TECHINCAL MEMORANDUM: SURVEY OF MUNICIPAL STORMWATER OPERATIONS AND MAINTENANCE PROGRAMS

SAM Effectiveness Study: BMP Maintenance Conditions Evaluation

Prepared for: City of Bellevue and Washington State Department of Ecology

Project No. 200203 • September 28, 2022

Aspect CONSULTING

earth + water

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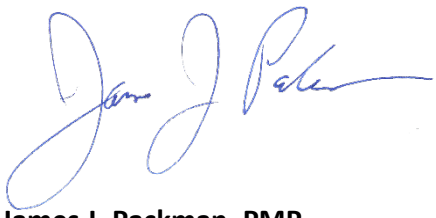

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Acronyms

APWA	American Public Works Association
Aspect	Aspect Consulting, LLC
BMP	Best Management Practice
Ecology	Washington Department of Ecology
FTE	full-time equivalent staff
GIS	Geographic Information System
IDDE	Illicit Discharge Detection and Elimination
LID	low impact development
NPDES	National Pollutant Discharge Elimination System
OWS	Oil-water separator
O&M	Operations and Maintenance
PARIS	Ecology's Water Quality Permitting and Reporting Information System
SAM	Stormwater Action Monitoring
Study	This SAM study
SWG	Stormwater Work Group
SWMMWW	Stormwater Management Manual for Western Washington
SWPPP	Stormwater Pollution Prevention Plan
TAC	Technical Advisory Committee
TAPE	technology assessment protocol - Ecology
WSC	Washington Stormwater Center
WSDOT	Washington State Department of Transportation

Executive Summary

This memorandum summarizes the findings from a survey of municipal jurisdictions about operations and maintenance (O&M or O-M) of stormwater best management practices (BMPs). The findings support a Stormwater Action Monitoring (SAM) Effectiveness Study (Study) that is focused on how western Washington municipal stormwater permittees of the National Pollutant Discharge Elimination System (NPDES) are implementing O&M programs as required under the permits.

The Study goal is to evaluate the maintenance thresholds, or conditions, for selected BMPs in the 2019 Stormwater Management Manual for Western Washington (SWMMWW). The survey results summarized in this memorandum support the Study goal by collecting and evaluating information about municipal O&M programs and maintenance of specific types of BMPs. Toward that end, the survey questions inquired about O&M program staffing and budgets, BMPs in use, reasons for BMP maintenance, maintenance standards and reference documents used, and record-keeping and data collection for O&M activities.

In total, 57 survey responses were submitted by 10 Phase I permittees, 45 Phase II permittees, and one individual permittee. In total, this represents 44 percent of all municipal stormwater permittees in western Washington. The survey included 17 questions and is provided in this memorandum as Appendix A.

The findings from this survey shine a light on municipal O&M programs, including in regard to how jurisdictions maintain the four BMP types being studied here: ponds, trenches, tanks, and vaults. The maintenance conditions for these BMPs are in the SWMMWW BMP Maintenance Tables, which are provided in Appendix B of this memorandum. The BMP Maintenance Tables are provided by Ecology as guidance, and the permittees are allowed to adjust the frequency of BMP maintenance and the conditions that trigger maintenance based on demonstrated BMP performance.

Survey findings were determined by assessing and interpreting the frequency of the response options for each question. The responses are shown visually in bar graphs in Figures 2-16. Many findings from the survey are helpful to this Study and inform us what BMPs are in use, what maintenance actions occur in relation to maintenance standards, and what information and data are collected about O&M activities. Key findings include:

- Three of the four BMP types being studied here (ponds, trenches, and vaults) are in wide use, with ponds representing the greatest usage
- Tanks have the least usage with most respondents indicating none
- The most common maintenance activities were the same for ponds and trenches: vegetation management and sediment or trash removal
- Vaults and tanks both had cleaning-related maintenance ranked high and structural issues-related maintenance ranked low

- Respondents noted that most maintenance occurs after 25 percent or less of BMP inspections, however some indicated maintenance occurs after nearly all inspections
- Record-keeping, especially of costs for O&M programs, is widely practiced
- Much quantitative data are collected for O&M activities and can be used to help determine BMP maintenance activities and frequencies for comparison to the BMP Maintenance Tables guidelines
- A few types of information regarding BMP effectiveness is collected only by a few jurisdictions, including data related to water quality, habitat, and facility or BMP operation

In addition, some findings may be of immediate interest and help to some permittees and the Washington State Department of Ecology (Ecology). These include findings that illuminate the many ways permittees organize and run their O&M programs and comply with permit requirements. Ecology may consider using these findings to inform the permit reissuance in 2024, the process for which has already begun. These include:

- Maintenance for ponds, vaults, and tanks occurs similarly in frequency among Phase I and Phase II permittees; maintenance frequency on trenches, however, varies more among permittees for maintenance measures related to complaints, erosion issues, and flooding.
- The O&M guidance and maintenance standards used by jurisdictions includes many reference documents. The Ecology SWMMWW is the most widely used, but also site-specific plans and field data and observations are used for guidance on BMP performance standards and maintenance thresholds.
- The number and mix of BMPs in use and the reasons for BMP maintenance can reflect the permittee type, size, and geography. For example, the individual permittee (WSDOT) indicated a high number of trenches, which is logical given the linear geography of roads.

1 Introduction

This technical memorandum provides a summary of a survey performed for a Stormwater Action Monitoring (SAM) study (Study). The SAM Study focuses on operations and maintenance (O&M or O-M) of stormwater best management practices (BMPs) and is being implemented by the City of Bellevue (City) and Aspect Consulting, LLC (Aspect). The SAM studies are administered by the Washington State Department of Ecology (Ecology) and support municipal permittees of the National Pollutant Discharge Elimination System (NPDES) in Washington State. Funding for the Study was provided by the permittees themselves via the SAM program.

1.1 BMP Maintenance Conditions Evaluation SAM Study

The Study goal is to evaluate the maintenance thresholds, or conditions, for selected stormwater best management practices (BMPs) in the 2019 Stormwater Management Manual for Western Washington (SWMMWW, Ecology, 2019a). This Study topic was identified as a priority related to stormwater BMPs by the SAM Effectiveness Subgroup and the Stormwater Work Group (SWG) for Puget Sound, both administered by Ecology. In addition to evaluating BMP maintenance thresholds, the Study also indirectly addresses two other priority study topics that included BMPs and wildlife habitat considerations and a controlled field study of BMP maintenance practices.

The maintenance thresholds being evaluated are from Appendix V-A: BMP Maintenance Tables of Volume V of the SWMMWW, which has BMPs for runoff treatment, flow control, and a library of the preferred low impact development (LID) BMPs (Ecology, 2019b). The BMP Maintenance Tables have maintenance standards for 23 types of BMPs, and is fully included in Appendix B of this document for reference. For this Study, we are focused on four types of BMPs that are in widespread use: ponds, tanks, trenches, and vaults. In the BMP Maintenance Tables, the BMPs being evaluated in this Study are represented by three types of ponds, one type of tank, six types of trenches, and one type of vault.

The objectives to meet the Study goal include a survey of municipal O&M programs, the results of which are summarized in this memorandum.

1.2 Municipal Programs Survey

The survey included 17 questions in total and is provided in Appendix A. The goal of the survey is to collect and evaluate information about municipal O&M programs and maintenance of BMPs in support of the overall Study goal. Toward that end, the survey questions inquired about O&M program staffing and budget, BMPs in use, maintenance standards and priorities, and data collection and record-keeping.

2 Survey Development

The survey was developed through a combination of background document review, draft questions iteration and refinement, and review by the Study's technical advisory committee (TAC). Once ready, the survey was distributed to municipal stormwater permittees via several channels as described below using an email announcement.

2.1 Background Documents Reviewed

Background documents were reviewed when developing the Survey questions, including:

- *Stormwater Management Manual of Western Washington* (Ecology, 2019a)
    - This includes specifically the BMP Maintenance Tables of Appendix V-A of Volume V. (Ecology, 2019b; included as Appendix B)
- *Highway Runoff Manual* (Washington State Department of Transportation (WSDOT) 2019).
- *King County Surface Water Design Manual (King County 2021)*
- *Clark County Stormwater Manual (Clark County 2021)*

2.2 Review and Distribution of Survey

Once the Study team had the draft survey questions ready, the TAC reviewed them and provided comments and feedback. The survey questions were then finalized and transferred to MS Forms, the online platform used to collect responses.

The email announcement for the survey went out on July 6, 2022 with a request to respond by August 1. The announcement was distributed via several email lists and listservs that included all of the western Washington municipal stormwater permittees as recipients. These included:

- Announcement forwarded by the Ecology regional permit managers to their permittees throughout western Washington
- Announcement included in Washington Stormwater Center (WSC) Municipal Permittee Bulletin on two biweekly publication dates in July
- Announcement sent to:
    - SAM listserv
    - SWG listserv
    - Regional NPDES Permit Coordinators groups (via WSC)
    - American Public Works Association (APWA) Stormwater Management Committee, Washington State Chapter

The response time was extended to August 5, at which time the response data was downloaded with 57 responses.

3 Survey Responses

The survey responses are summarized in this section.

3.1 Respondents, Staffing, and Budgets (Questions 1-4)

The first four questions of the survey asked responders to indicate information about the jurisdictions they represent.

Question 1: what type of permittee they are—Phase I or Phase II—along with if they are a primary or secondary permittee

Question 2: jurisdiction name

Question 3: how many staff perform stormwater O&M

Question 4: approximate total annual O&M budget

3.1.1 Respondents

In total, 57 permittees responded to the survey, which is approximately 44 percent of the 130 Phase I and Phase II western Washington permittees. The breakdown is provided in the table below, and attached Table 1 provides a listing of the survey respondents by jurisdiction. In addition, Figure 1 shows a pie chart with the distribution of respondents by permittee type.

Permittee Type	Respondents	Notes
Phase I	6 (out of 6)	100% response
Phase I Secondary	4 (out of 9)	44% response
Phase II	45 (out of 87)	52% response
Phase II Secondary	1 (out of 28)	3% response
Individual	1	State agency

Most respondents represented primary permittees, but several secondary permittees completed the survey, too. Secondary permittees have fewer O&M requirements under their *Pollution Prevention and Good Housekeeping for Municipal Operations* requirements than primary permittees do in their *Operations and Maintenance Program* requirements. The secondary permittee responses to the survey are valuable, too, since secondary permittees are required to maintain BMPs, and some requirements are the same as primary permittees, including establishing maintenance standards and record-keeping consistent with an O&M plan. Secondary permittees do, however, have simpler inspection requirements of BMPs and a shorter list of specific O&M activities to address than primary permittees.

3.1.2 Staffing

Question 3 asked about the number and type of staff working in municipal O&M in the respondent's jurisdiction. Answer options of internal full-time equivalent (FTE) staff were provided from 0.10 to more than 20 FTEs (see Figure 2). In addition, respondents were asked to indicate if they also use external consultants or vendors. Most jurisdictions indicated 1.25-5 FTEs and no consultants or vendors. Phase I and Phase II permittees were represented in every FTE grouping except the smallest of 0.1-1 FTE, which was represented by just Phase II permittees. The second highest staffing level was 10.25-20 FTEs, of which two permittees also used consultants or vendors. Notably, one Phase II permittee indicated no internal FTEs but rather just one consultant or vendor for O&M.

3.1.3 Budgets

Question 4 asked about the approximate annual total budget for all stormwater-related O&M activities. Answer options were ranges of round values from less than $0.1 million to more than $5 million annually (see Figure 3). Most permittees indicated O&M budgets in the $1-$2.5 million range followed by an even number of permittees who indicated budgets in the $0.25-$0.5 million range and the $2.5-$5 million range. Notably, several respondents indicated annual budgets of more than $5 million, including some Phase I, Phase II, and individual permittees.

3.2 BMPs and O&M (Questions 5-13)

Questions 5 through 14 of the survey focused on the four types of BMPs of interest to this Study: ponds, tanks, trenches, and vaults.

3.2.1 BMPs In Use

Question 5 of the survey asked about specific types of BMPs that are operated, maintained, or regulated by the permittee. With a focus on the general four categories of BMPs being studied here, the question asked specifically about four types of ponds, two types of tanks, four types of trenches, and four types of vaults. In addition, an "other" option was provided for each general BMP type, and an option was provided for proprietary BMPs that are types of ponds, tanks, trenches, or vaults.

The results show that permittees use all BMP types listed with one or more BMP types being used in all four categories. Figure 4 shows the full breakdown by BMP type and permittee type, and the table below summarizes the BMPs with the most, moderate, and least use that corresponds, respectively, to greater than 40 permittees, 20-40 permittees, and less than 20 permittees.

BMP Category	Most Use (>40 permittees)	Moderate Use (20-40 permittees)	Least Use (<20 permittees)
Pond	Detention/wetpond Infiltration/bioretention pond	Other type of pond	
Tank	Below ground tank		Above ground tank Other type of tank
Trench	Biofiltration swale	Filter strip Infiltration trench	Sand vault Other type of trench
Vault	Wetvault Oil-water separator (OWS) Other media		Sand vault Other type of vault

3.2.2 Ponds

Question 6 of the survey asked about how many stormwater ponds of all types are inspected and maintained by the respondent's jurisdiction. Ranges of answers were provided, including 0, 1-5, 6-10, 11-20, 21-40, and 41 or more ponds. Results are shown on Figure 5, which indicates that almost half of respondents (26) have more than 41 ponds they maintain, including the majority of Phase I permittees. Generally, fewer ponds were associated with fewer jurisdictions, and a couple respondents indicated no ponds that they maintain.

Question 7 delved deeper into pond maintenance with asking about the reasons for maintenance. Ten answer options were provided of common issues with ponds that require maintenance, and respondents were asked to rank the answer options from most to least. Results are provided on Figure 6, which lists the reasons for pond maintenance alphabetically and shows the frequencies that each maintenance activity was ranked from 1st to 10th. The most common pond maintenance activity (1st rank) was vegetation management, which consistently ranked high (all answers from 1st to 4th rank). Second most common was sediment or trash removal, which also consistently ranked high (most answers from 1st to 4th rank). Maintenance activities with consistently moderate ranking (most answers between 3rd and 7th ranks) included: cleaning, dredging, or replacing media; complaint responses; and repair or adjustment of the facility. Pond maintenance activities that ranked the lowest were issues due to animals (such as beaver dams), which always ranked moderate to low (most answers 5th to 10th rank), and similarly low rankings for issues related to habitat protection and spill response or clean-up.

3.2.3 Trenches

Question 8 of the survey asked about how many stormwater trenches of all types are inspected and maintained by the respondent's jurisdiction. Ranges of answers were provided, including 0, 1-5, 6-10, 11-20, 21-40, and 41 or more trenches. Results are shown on Figure 7, which indicates that almost half of respondents (24) have more than 41 trenches they maintain, including the majority of Phase I permittees. The second most common number of trenches is the 1-5 range and is represented by Phase I and Phase II permittees. Five Phase II respondents indicated no trenches that they maintain.

Question 9 delved deeper into trench maintenance with asking about the reasons for maintenance. Ten answer options were provided of common issues with trenches that require maintenance, and respondents were asked to rank the answer options from most to least. Results are provided on Figure 8, which lists the reasons for trench maintenance alphabetically and shows the frequencies that each maintenance activity was ranked from 1st to 10th. The most common trench maintenance activity (1st rank) was vegetation management, which consistently ranked high (all answers 1st to 4th rank). Second most common was sediment or trash removal, which also consistently ranked high (most answers from 1st to 5th rank). Trench maintenance activities with consistently moderate ranking (most answers between 3rd and 7th rank) included: cleaning, dredging, or replacing media; complaint responses; flooding; and repair or adjustment of the facility. Trench maintenance activities that ranked the lowest were issues due to vandalism and spill response (most answers 5th to 10th rank).

3.2.4 Vaults

Question 10 of the survey asked about how many stormwater vaults of all types are inspected and maintained by the respondent's jurisdiction. Ranges of answers were provided, including 0, 1-5, 6-10, 11-20, 21-40, and 41 or more vaults. Results are shown on Figure 9, which indicates that almost half of respondents (27) have more than 41 vaults they maintain, including the majority of Phase I permittees. The second most common number of vaults is the 1-5 range and is represented by Phase I and Phase II permittees. Four Phase II respondents indicated no vaults that they maintain.

Question 11 delved deeper into vault maintenance with asking about the reasons for maintenance. Ten answer options were provided of common issues with vaults that require maintenance, and respondents were asked to rank the answer options from most to least. Results are provided on Figure 10, which lists the reasons for vault maintenance alphabetically and shows the frequencies that each maintenance activity was ranked from 1st to 10th. The most common vault maintenance activity (1st rank) was sediment or trash management, which consistently ranked very high (most answers 1st or 2nd rank). Second most common was maintenance due to cleaning, dredging, or replacing media with most responses from 2nd to 6th rank. Most vault maintenance activities were ranked moderately with most answers between 3rd and 8th ranks, including flooding, spill response, complaint response, and vegetation management. Vault maintenance activities that ranked the lowest were issues due to habitat, seepage or structural issues or due to vandalism (most answers 7th to 10th rank).

3.2.5 Tanks

Question 12 of the survey asked about how many tanks of all types are inspected and maintained by the respondent's jurisdiction. Ranges of answers were provided, including 0, 1-5, 6-10, 11-20, 21-40, and 41 or more tanks. Results are shown on Figure 11, which indicates that more than two-thirds of respondents (21) have no tanks they maintain, an answer represented by Phase I and Phase II permittees as well as secondary permittees. The second most common number of tanks is in the 1-5 range and 41 or more range with approximately the same number of permittees represented (11 and 12, respectively).

Question 13 delved deeper into tank maintenance with asking about the reasons for maintenance. Nine answer options were provided of common issues with tanks that require maintenance, and respondents were asked to rank the answer options from most to least. Results are provided on Figure 12, which lists the reasons for tank maintenance alphabetically and shows the frequencies that each maintenance activity was ranked from 1st to 10th. The most common tank maintenance activity (1st rank) was cleaning, which consistently ranked very high (most answers 1st or 2nd rank). Second most common was maintenance due to damage assessment or tank repair or operational testing with most responses from 1st to 4th rank. Most tank maintenance activities were ranked moderately with most answers between 3rd and 9th ranks, including complaint response, replacing parts or equipment, vandalism, and ventilation. Tank maintenance activities that ranked the lowest were issues due to seepage or structural issues or due to vandalism (most answers 7th to 10th rank).

3.3 Maintenance Frequency and Standards (Questions 14-15)

Question 14 of the survey asked what percentage of BMPs require maintenance following an inspection. Answer options were given in ranges including <10 percent, 11-25 percent, 26-50 percent, 51 to 75 percent, and 76-100 percent. Results are summarized on Figure 13, and both Phase I and Phase II permittees were represented across the range of answer options. The most common response of maintenance being required after an inspection was 11-25 percent of the time, followed by an equal number of responses (14 each) for less than 10 percent of the time and 26-50 percent of the time. Least common was just two responses for maintenance occurring 76-100 percent of the time after BMP inspection.

Question 15 of the survey asked about what guidance is used for maintenance standards for BMPs. Nine answer options were provided of common guidance manual and standards, and an "other" option was provided to type in a different answer if desired. Results are summarized on Figure 14 and show that the most common manual and standards used is the Ecology SWMMWW with 41 responses (72 percent).

The question was multiple choice, however, many respondents had multiple answers. and a high representation of use is also indicated for four other response options:

1. Other non-Ecology (but Ecology-approved) stormwater manuals
2. Stormwater pollution prevention plans (SWPPPs) or other site-specific plans
3. Standard operating procedures
4. Field data

Less used are the remaining four response options:

5. General O&M plans
6. Documentation of "practices, policies, and procedures" (per permit sections S5.C7.d for Phase IIs or S5.C10.e for Phase Is)
7. Maintenance procedures associated with Ecology's technology assessment protocol (TAPE) certification
8. WSDOT Highway Runoff Manual

No "other" guidance was noted to be used by any respondent.

3.4 Record-keeping and Documentation (Questions 16-17)

Question 16 of the survey asked what maintenance records are kept for maintenance inspections of stormwater BMPs and facilities. Fourteen answer options were provided of common information or activities that could be recorded during maintenance. An "other" option was also provided to type in a different answer if desired. Results are summarized on Figure 15 and show that the most common answer was information recorded for

vegetation management, with 53 responses. But five other types of recorded information or activities were also highly represented and had 46 to 49 responses each.

1. Observations associated with maintenance standards
2. Maintenance dates
3. Spot checks
4. Trash or debris presence
5. Photos or videos

A few types of information had low representation, including BMP functionality testing and observations about water quality, along with a few responses indicating "other" unspecified information. The one category with no information recorded was observations of habitat.

Question 17 of the survey asked about what types of quantitative data are collected during BMP maintenance activities. Eleven answer options were provided of data that could be collected associated with common maintenance activities. An "other" option was also provided to type in a different answer if desired. Results are summarized on Figure 16 and show that labor hour data was the most commonly collected (45 responses) along with data about sediment or solids accumulation (42 responses) and equipment cost (37 responses).

Second most collected is data regarding oil or floatables accumulation (30 responses), vendor costs (29 responses), and data about vegetation maintenance (21 responses). Third most collected data is amount of material removed (17 responses) and water level or flow (12 responses). Finally, a few data types had low representation with five or fewer response each. These included:

- Water quality data
- Habitat data
- Facility operation data
- Other unspecified data

4 Discussion

The outcomes from this survey shine a light on municipal O&M programs and help advance the Study goals by understanding what BMPs are in use, what maintenance is performed, and what information and data are recorded. The findings, which are summarized below, provide insights that benefit the remaining Study tasks, which include:

- Task 3: Published BMP Maintenance Data Review—survey findings help guide literature searches and O&M data comparison for BMP types
- Task 4: Interviews with Ecology Staff Regarding the BMP Maintenance Thresholds—survey findings helpful in developing questions for Ecology staff considering how some O&M permit requirements are implemented
- Task 5: Pilot Data Analysis of Permittee O&M Data—survey findings used as basis to determine what information could be used or collected in a pilot study of BMP maintenance data
- Task 6: White Paper—survey findings will help summarize the overall outcomes of the Study

In addition, Ecology and permittees may benefit from the survey findings now in regard to how permittees implement their O&M programs. Information including what BMPs are in use and the maintenance activities performed can help Ecology and permittees better understand how O&M permit requirements are being implemented across the region.

Survey responses were received from all types of municipal stormwater permittees, including Phase I and Phase II permittees, primary and secondary jurisdictions, and one state agency individual permittee. All Phase I primary permittees responded to the survey and are represented. However, the moderate response rate of the survey among Phase II presents some challenges in interpreting the data since it represents just 44 percent of municipal stormwater permittees in western Washington.

4.1 Findings that Help This Study

Many survey findings are generally helpful to this Study by guiding the subsequent tasks described above. Some specific findings are highlighted below.

- Three of the four BMP types being studied here (ponds, trenches, and vaults) are in wide use, with ponds representing the greatest usage.
- Trenches and vaults have high usage, too, but with more representation in fewer numbers in some jurisdictions.
- Tanks have the least usage with most respondents indicating none.
- The most common maintenance activities were the same for ponds and trenches—vegetation management and sediment or trash removal.

- Vaults and tanks had uniquely ranked maintenance activities, but both had cleaning-related maintenance ranked high and structural issues ranked low.
- Most maintenance occurs after 25 percent or less of BMP inspections, however some respondents indicated maintenance occurs after nearly all inspections.
- Record-keeping for O&M programs includes both qualitative information and quantitative data.
- The O&M data records recorded by permittees include information that can be used to help analyze how BMP maintenance thresholds and maintenance needs are determined.
- Staffing and budget levels for O&M programs is represented by a wide range and similar distributions of FTEs and annual budgets, respectively.
- While all respondents indicated the use of internal staff for O&M work, a few respondents (12 percent) indicated using vendors or consultants too.
- Some types of information or data about BMPs is collected only by a few jurisdictions, including water quality, habitat, and facility or BMP operation.

4.2 Findings for Permittees and Ecology

Findings from this survey may also be immediately helpful to municipal stormwater permittees to better understand how O&M programs are implemented across the region. Additionally, Ecology may review these findings to help inform the municipal stormwater permit reissuance in 2024, the process for which has already begun. These include:

- The maintenance performed on ponds, vaults, and tanks is similar in frequency of occurrence among Phase I and Phase II permittees; whereas the frequency of maintenance on trenches varies more among permittees for certain maintenance measures, including those related to complaints, erosion issues, and flooding
- Annual budgets for O&M range widely, and although most are in the $1-2.5 million range, some exceed $5 million annually
- The O&M guidance and maintenance standards used by jurisdictions includes many reference documents, especially the Ecology SWMMWW but also site-specific plans and based on observed field data related to standards and maintenance thresholds
- Most O&M data collected by jurisdictions is related to financial data, including labor hours, equipment costs, and vendor costs
- Only a few jurisdictions collect data (infrequently) that are related to BMP functionality, water quality, and habitat when applicable, e.g., ponds.

5 References

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Clark County, 2021, Clark County Stormwater Manual, updated 2021, Clark County, Washington: LINK

King County Surface Water Design Manual, updated July 2021, King County, Washington, Department of Natural Resources and Parks: LINK

WSDOT, 2019, Highway Runoff Manual, M31-16.05, April 2019, Washington State Department of Transportation. LINK

6 Limitations

Work for this project was performed for the City of Bellevue and the Washington State Department of Ecology (Clients), and this report was prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. This report does not represent a legal opinion. No other warranty, expressed or implied, is made.

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TABLE

Table 1. Survey Respondents

Project No. 200203, City of Bellevue and Aspect Consulting

Type	Entity	Jurisdiction
Phase I	City	Tacoma
		Seattle
	County	Clark
		Pierce
		Snohomish
		King
Phase I Secondary	Port	Port of Seattle
	State	unspecified (x2)
	University	Western Washington University
Individual	State	Washington State Department of Transportation
Phase II	City	Auburn
		Bainbridge Island
		Battle Ground
		Bellevue
		Bellingham
		Black Diamond
		Bothell
		Bremerton
		Covington
		Des Moines
		DuPont
		Edgewood
		Enumclaw
		Everett
		Kent
		Kirkland
		Longview
		Maple Valley
		Marysville
		Marysville
		Milton
		Moses Lake
		Mountlake Terrace
		Newcastle
		Orting
		Pacific
		Port Orchard
		Redmond
		Renton
		Sammamish
		SeaTac
		Sedro-Woolley
		Sumner
		Tumwater
		Vancouver
		Walla Walla
		unspecified (x 9)
	County	Thurston County

FIGURES

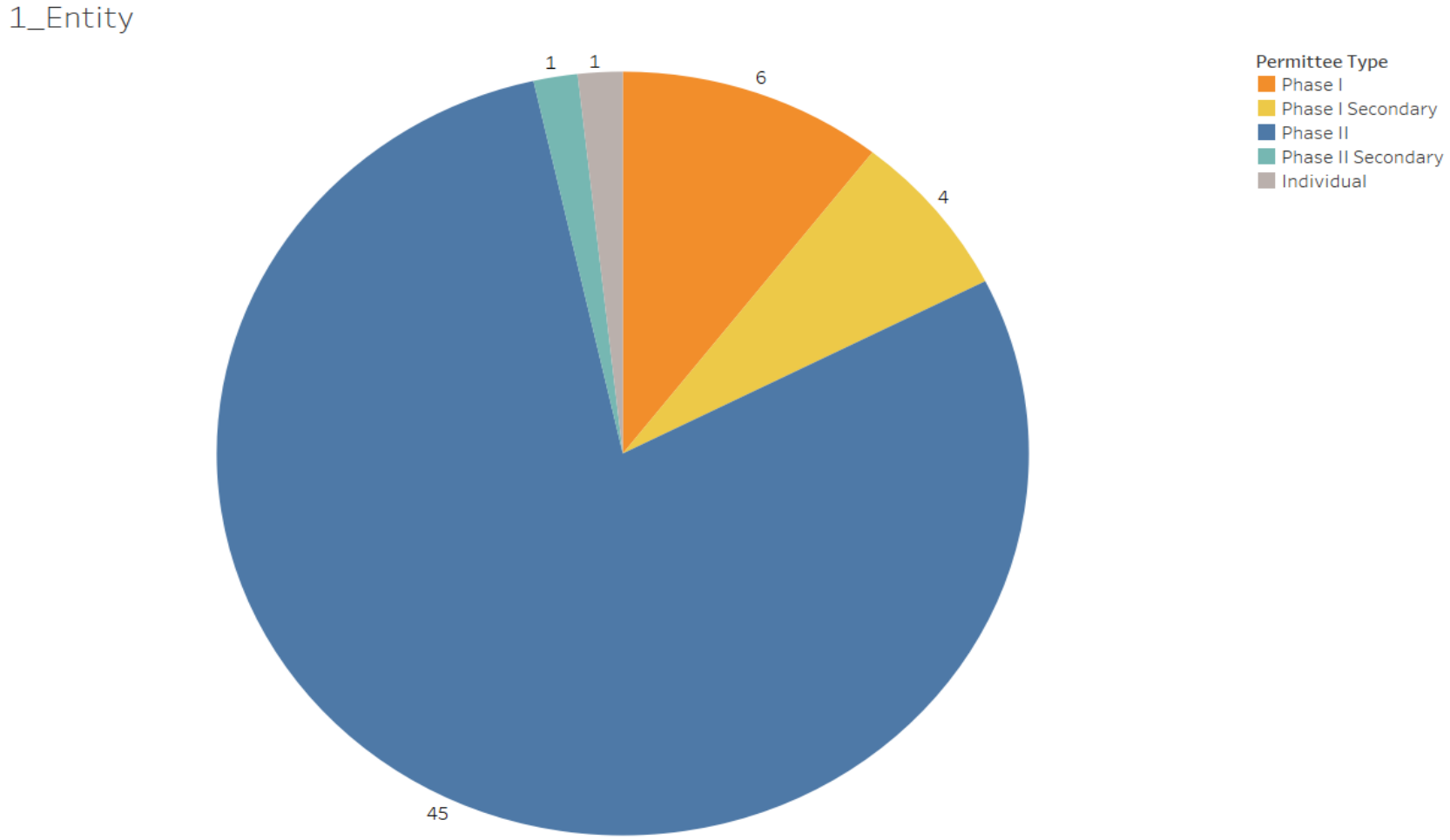


Figure 1
Responses by Permittee Type
Survey of Municipal Stormwater Operations and Maintenance
Project No. 200203
Stormwater O SAM Study

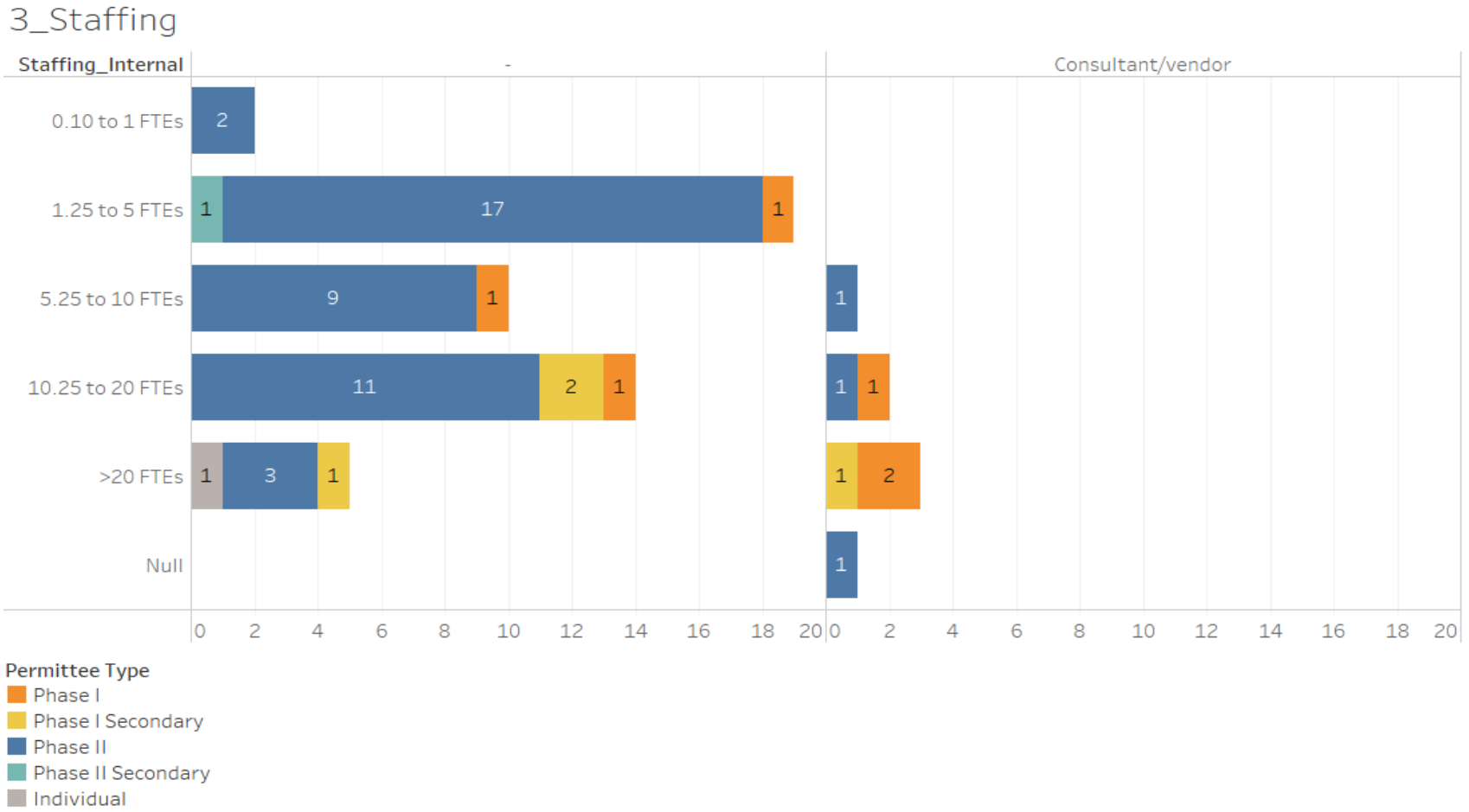


Figure 2
O-M Program Staffing
Survey of Municipal Stormwater Operations and Maintenance
Project No. 200203
Stormwater O-M SAM Study

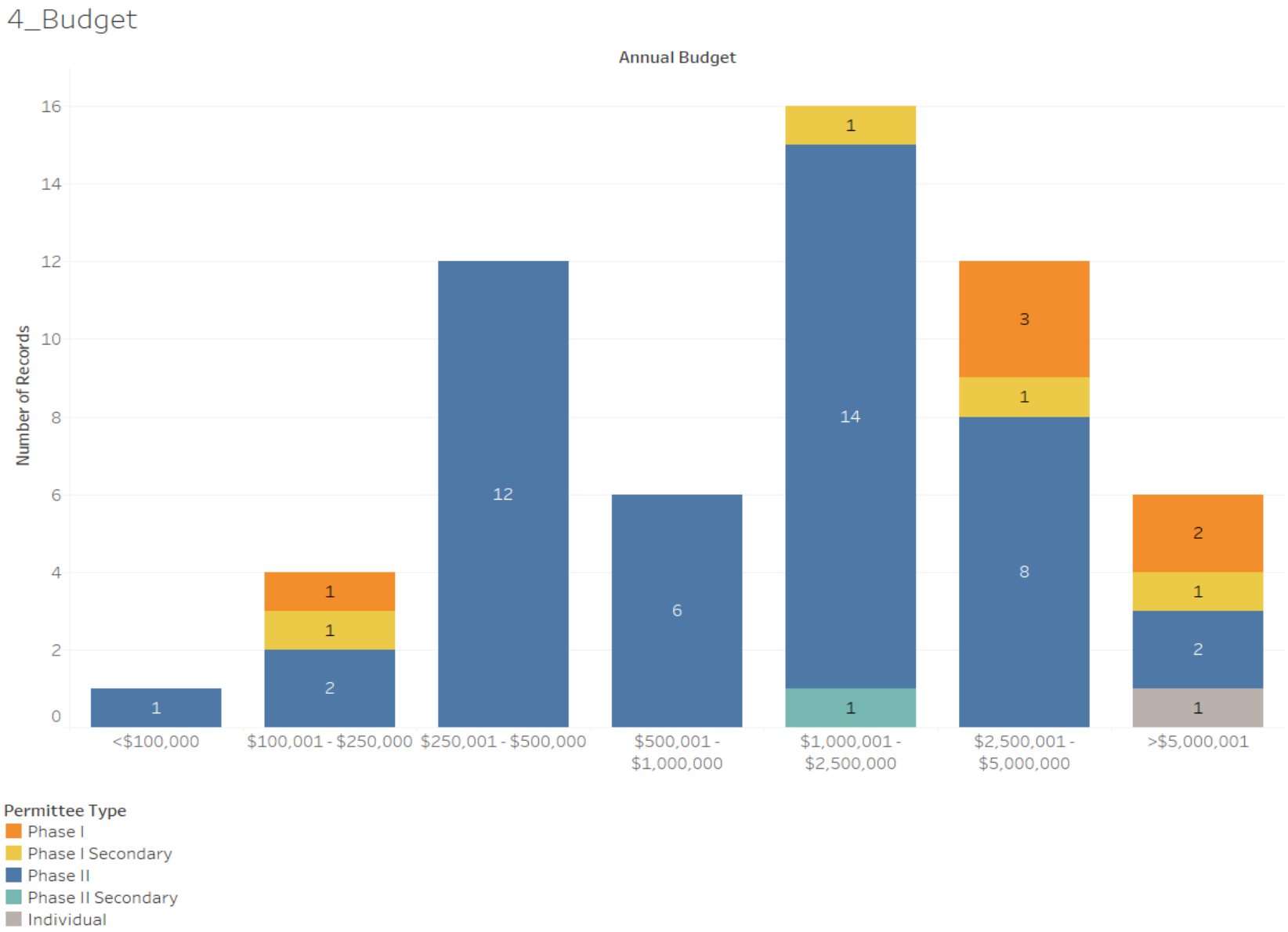


Figure 3
Annual Budgets for O-M
Survey of Municipal Stormwater Operations and Maintenance
Project No. 200203
Stormwater O SAM Study

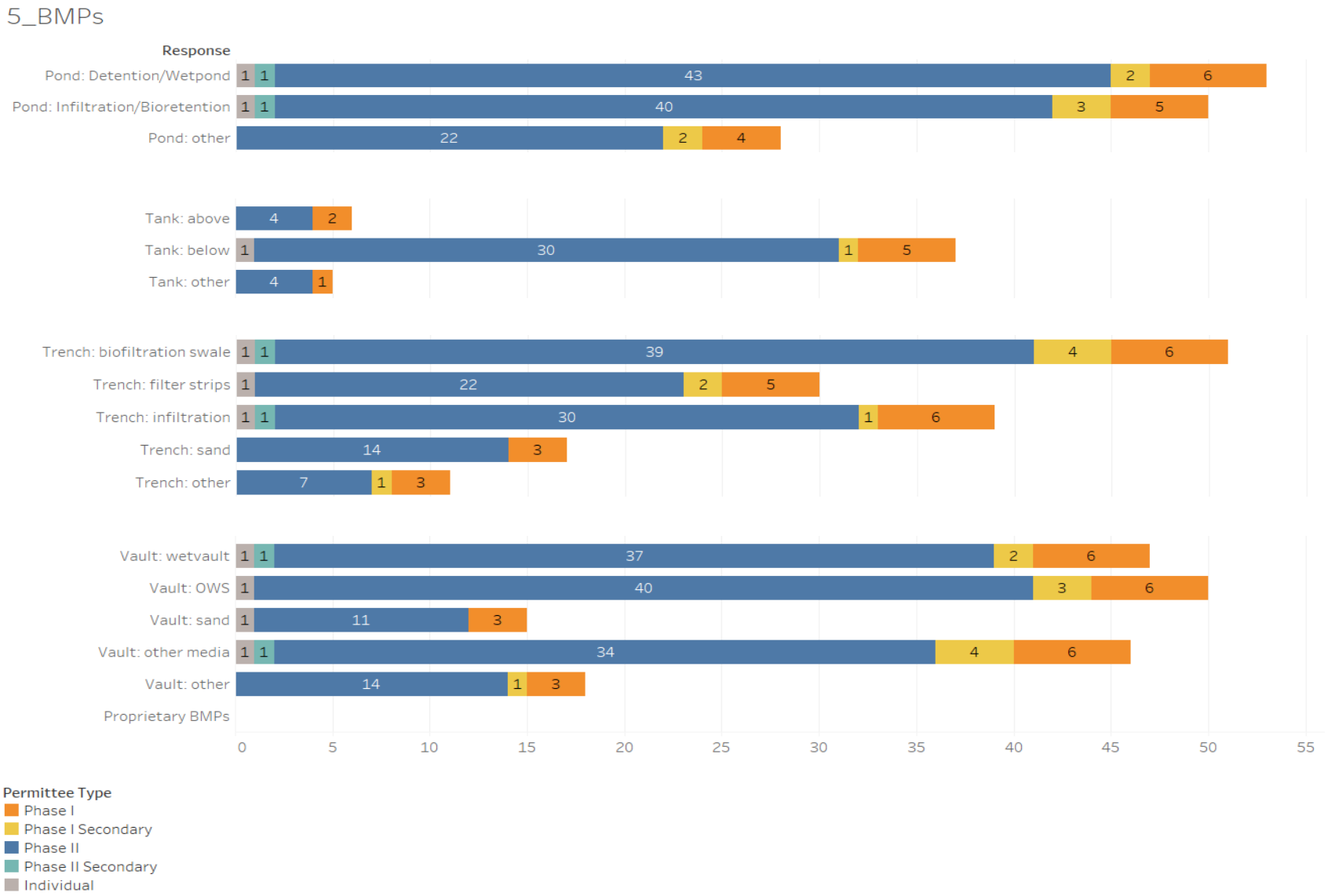


Figure 4
BMPs In Use
Survey of Municipal Stormwater Operations and Maintenance
Project No. 200203
Stormwater O-M SAM Study

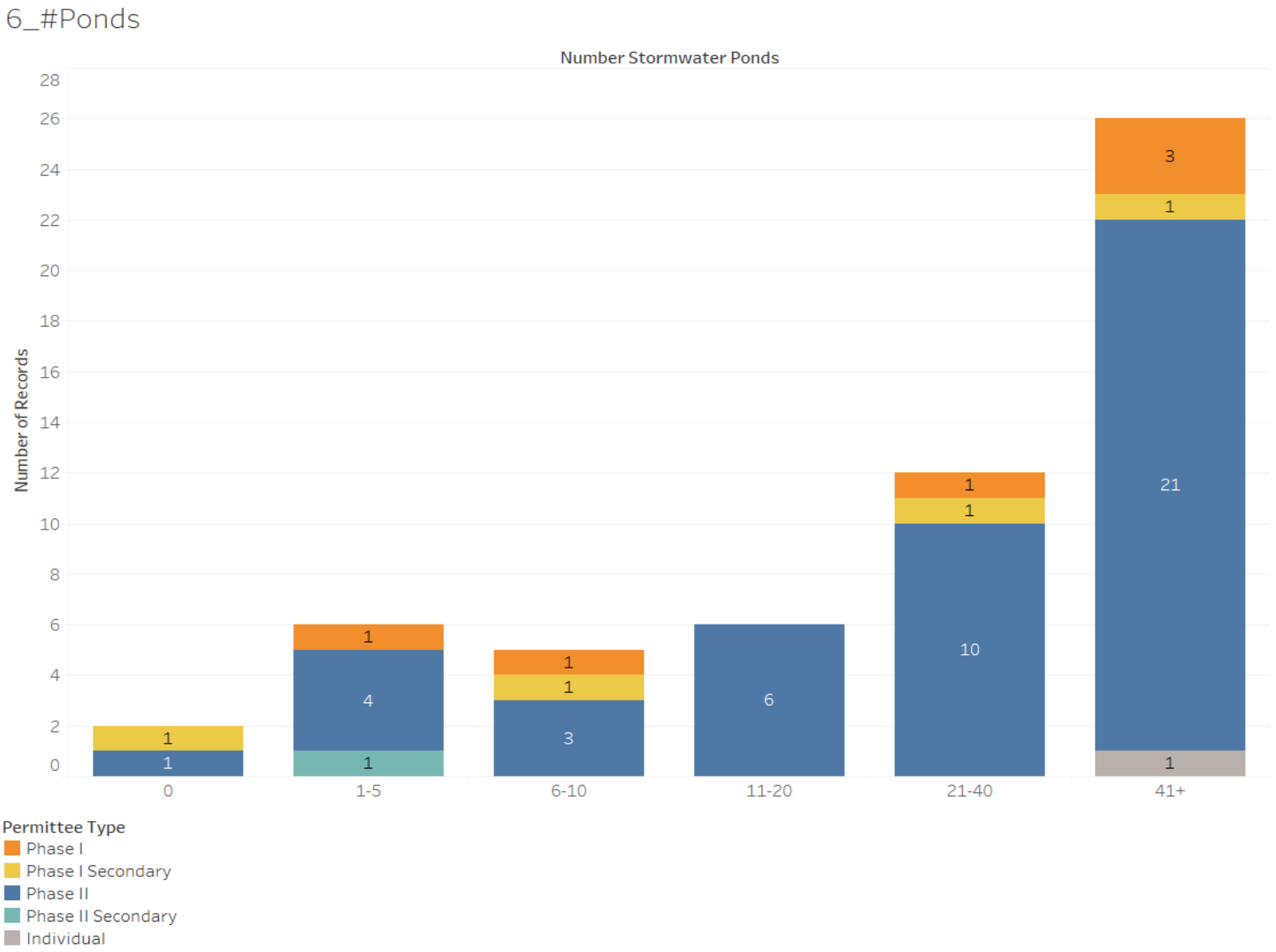
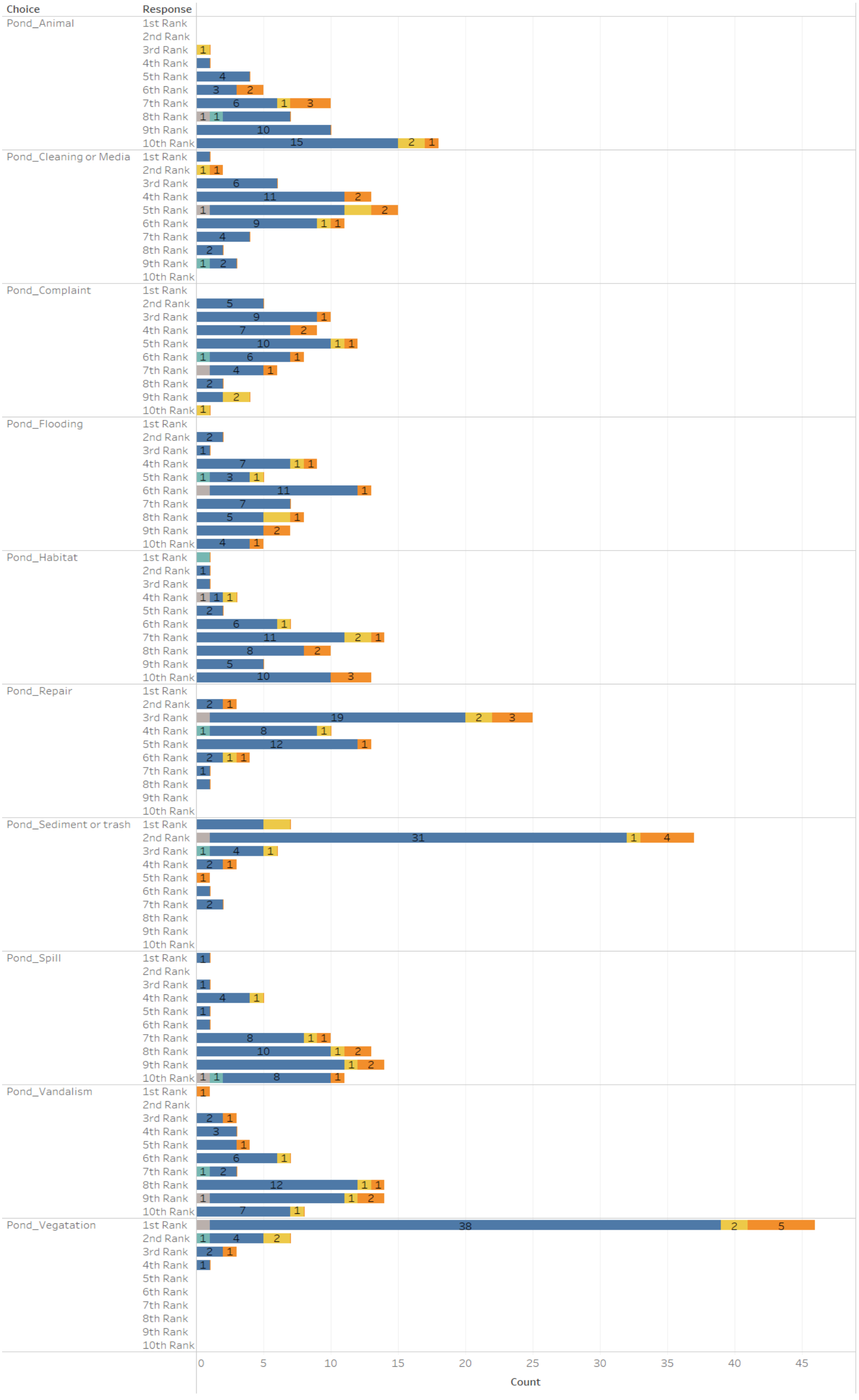


Figure 5
Number of Ponds Maintained
Survey of Municipal Stormwater Operations and Maintenance
Project No. 200203
Stormwater O SAM Study

7_Pond Maintenance



Permittee Type
- Phase I
- Phase I Secondary
- Phase II
- Phase II Secondary
- Individual

Figure 6
Pond Maintenance
Survey of Municipal Stormwater Operations and Maintenance
Project No. 200203
Stormwater O SAM Study

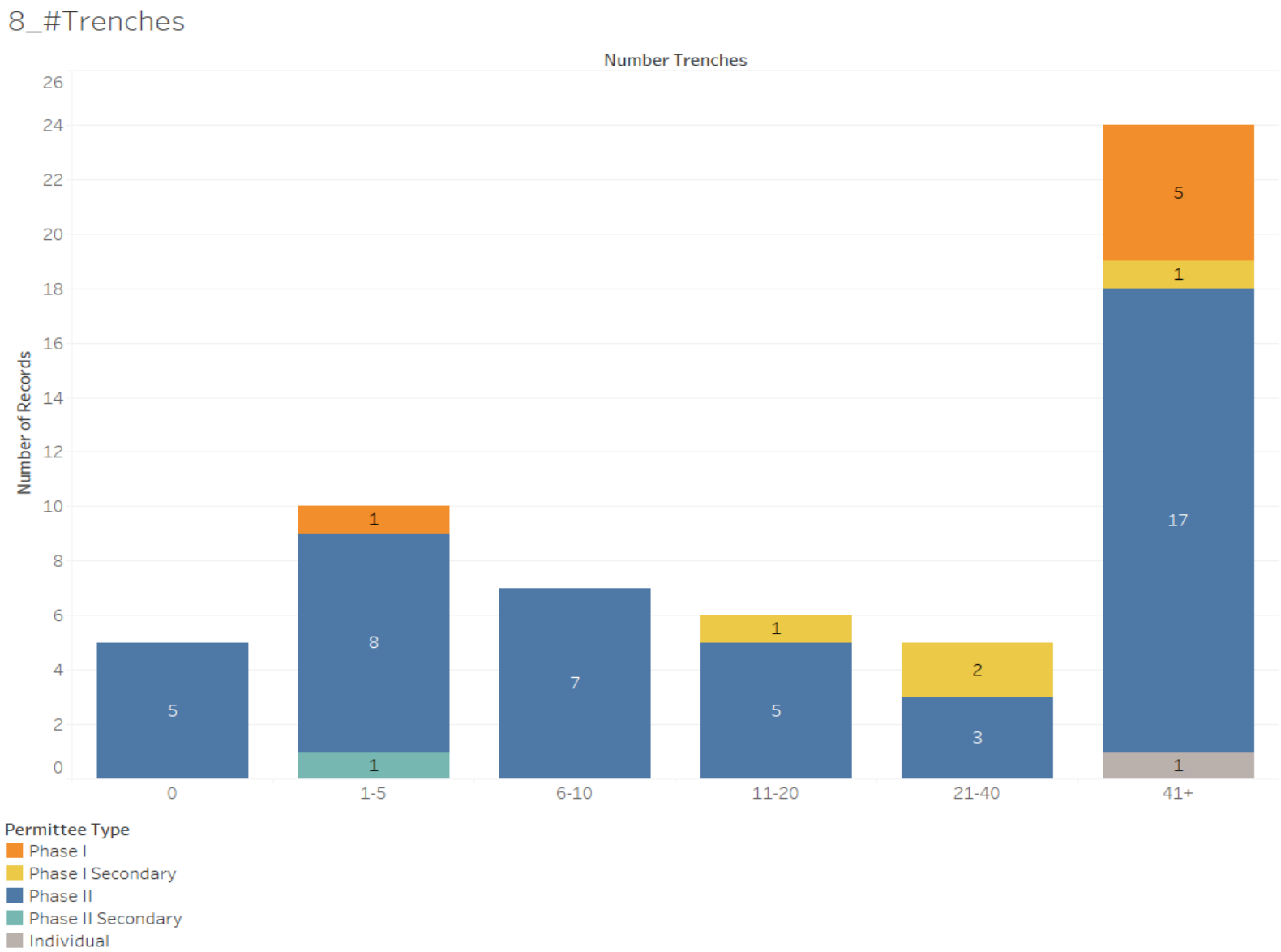


Figure 7
Number of Trenches Maintained
Survey of Municipal Stormwater Operations and Maintenance
Project No. 200203
Stormwater O SAM Study

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9_Trench Maintenance

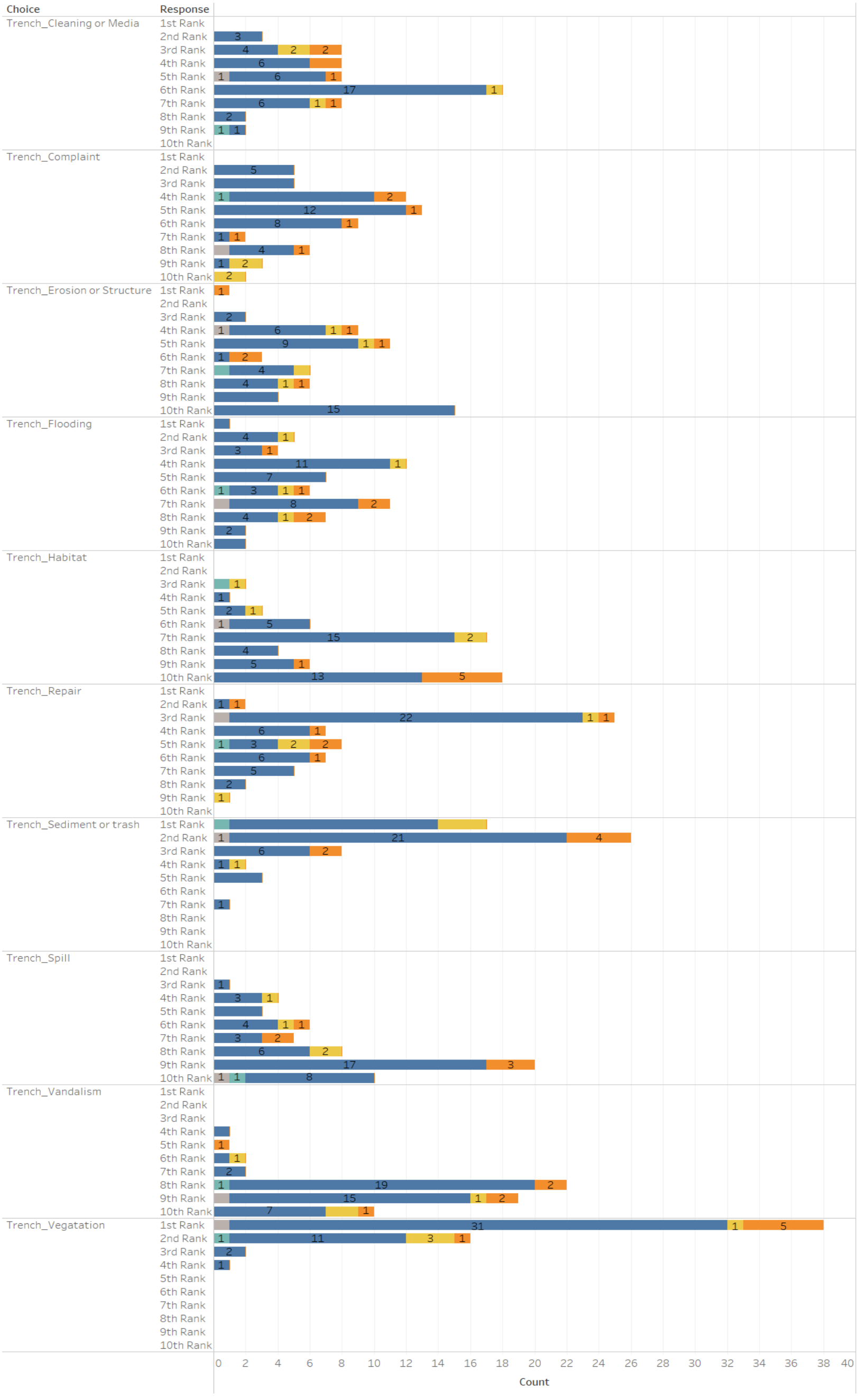

Figure 8
Trench Maintenance
Survey of Municipal Stormwater Operations and Maintenance
Project No. 200203
Stormwater O SAM Study

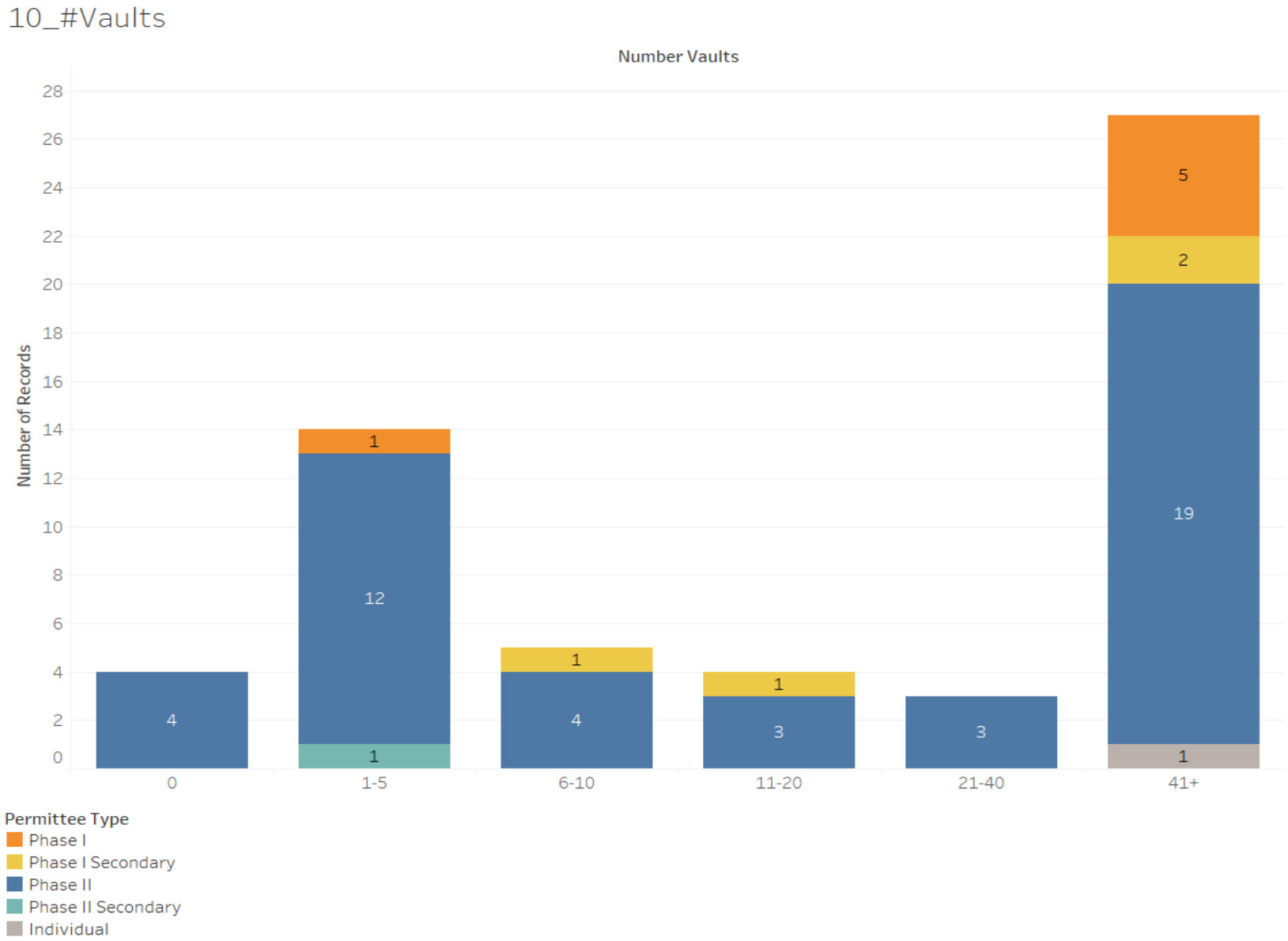

Figure 9
Number of Vaults Maintained
Survey of Municipal Stormwater Operations and Maintenance
Project No. 200203
Stormwater O SAM Study

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11_Vault Maintenance

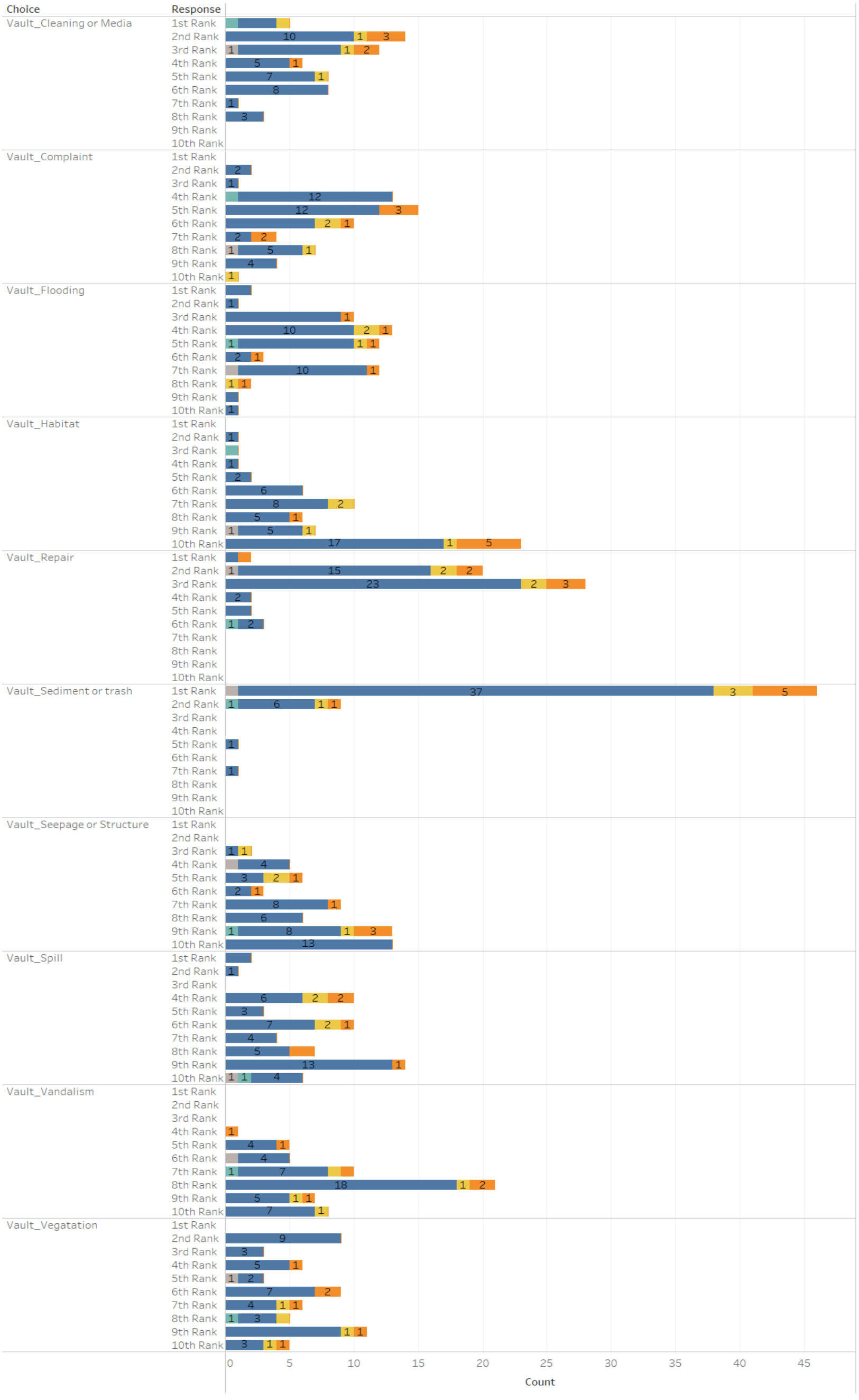

Figure 10
Vault Maintenance
Survey of Municipal Stormwater Operations and Maintenance
Project No. 200203
Stormwater O SAM Study

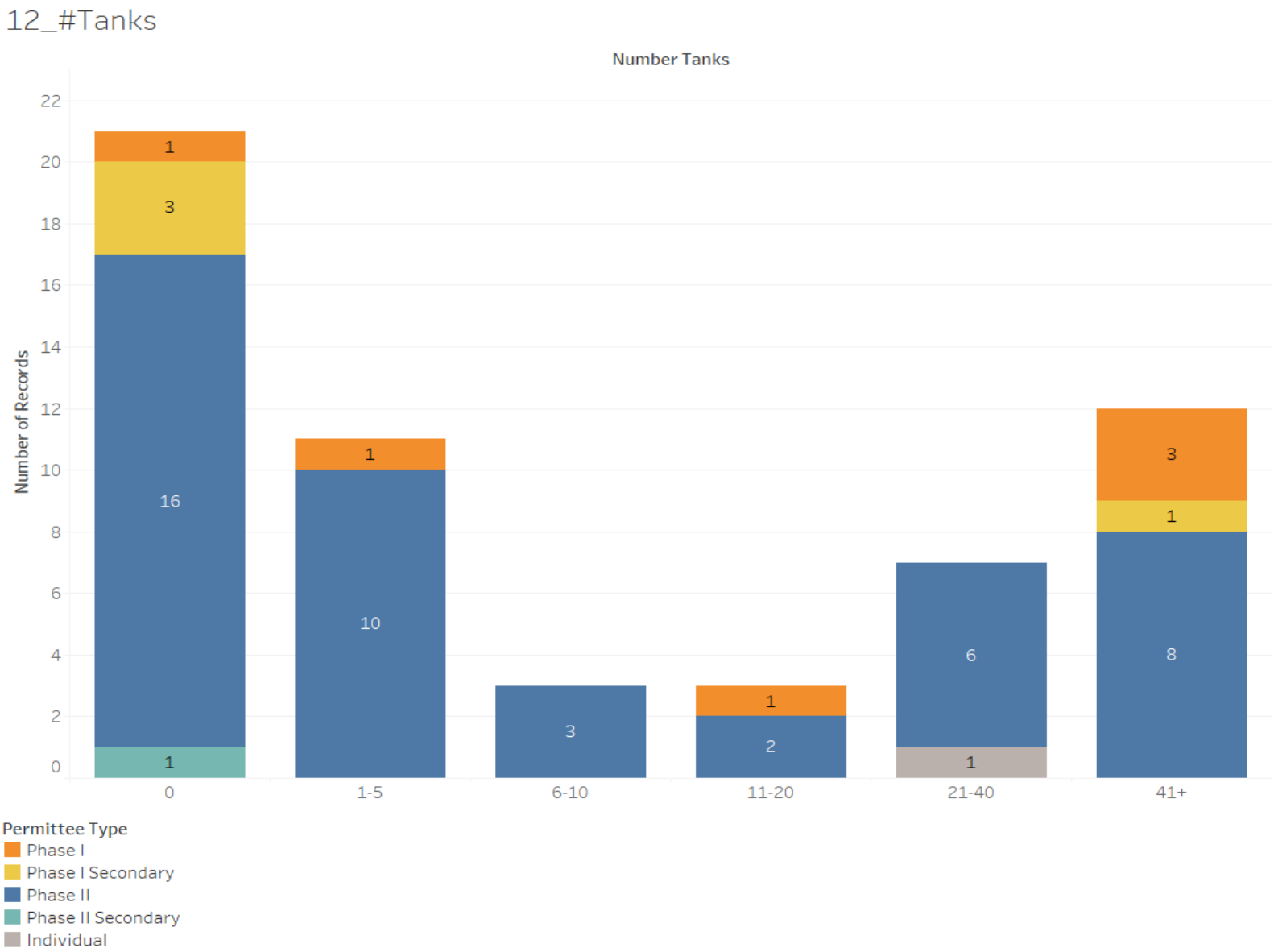

Figure 11
Number of Tanks Maintained
Survey of Municipal Stormwater Operations and Maintenance
Project No. 200203
Stormwater O SAM Study

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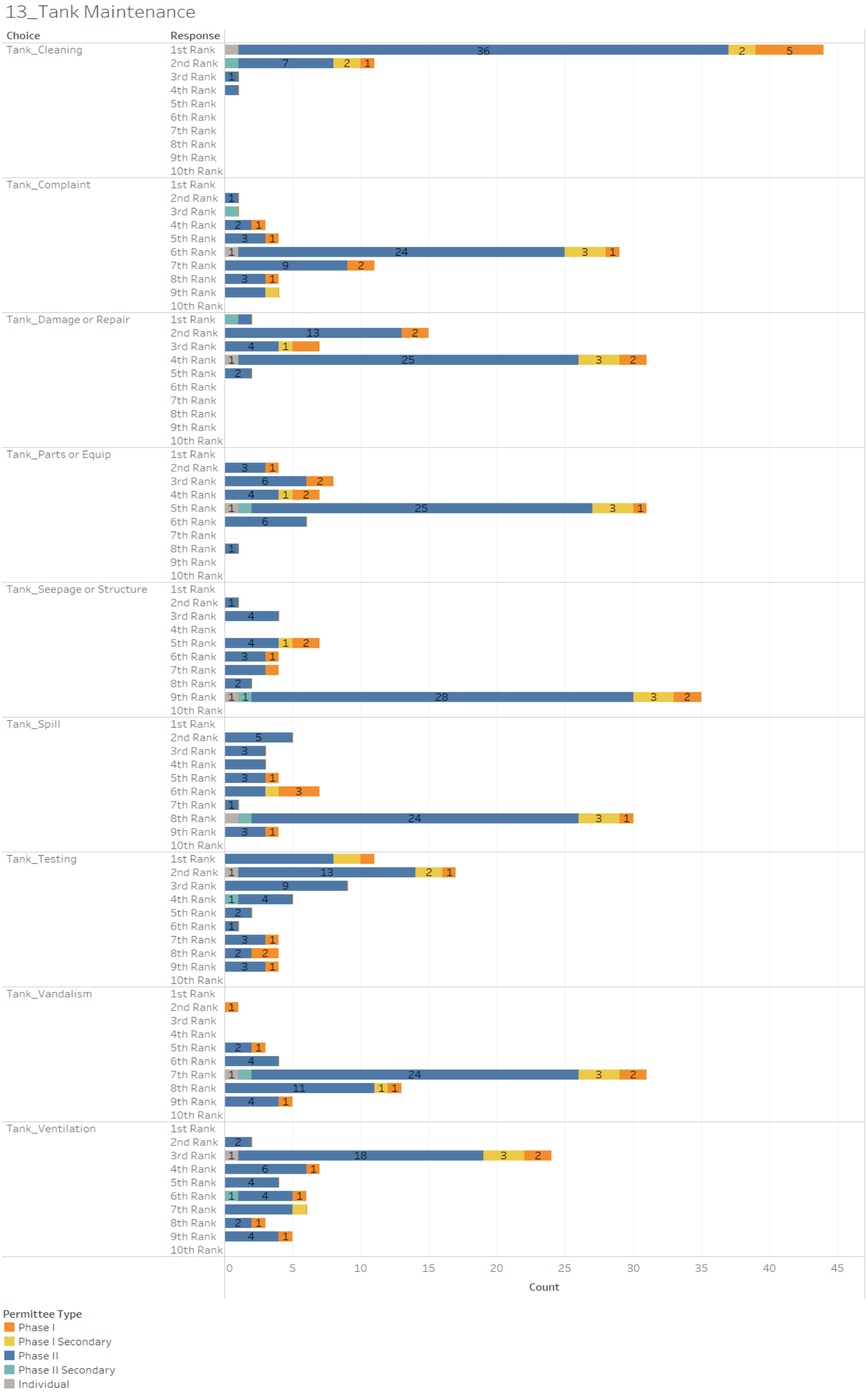

Figure 12
Tank Maintenance
Survey of Municipal Stormwater Operations and Maintenance
Project No. 200203
Stormwater O SAM Study

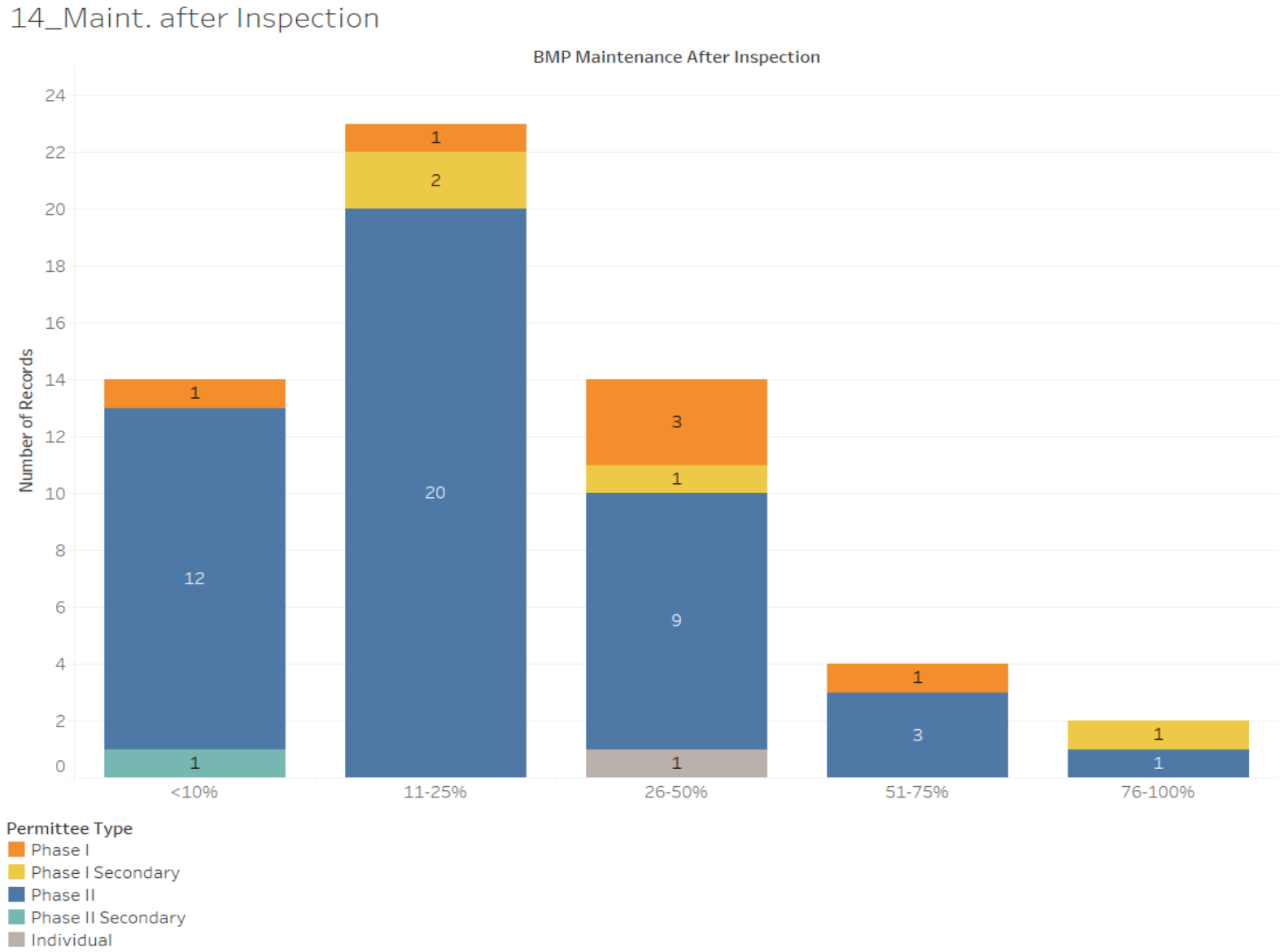

Figure 13
Maintenance After Inpsection
Survey of Municipal Stormwater Operations and Maintenance
Project No. 200203
Stormwater O SAM Study

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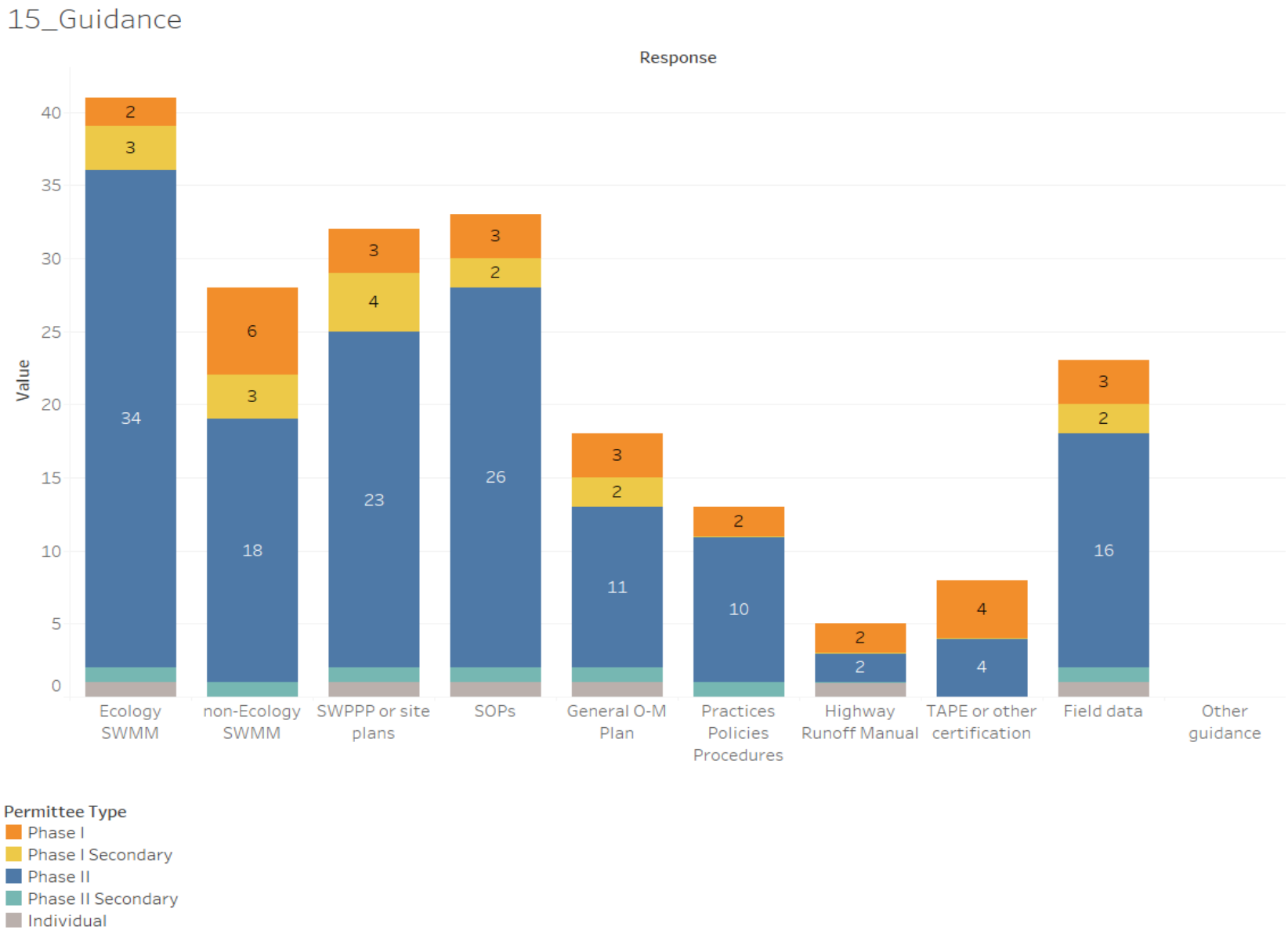

Figure 14
Maintenance Guidance Used
Survey of Municipal Stormwater Operations and Maintenance
Project No. 200203
Stormwater O SAM Study

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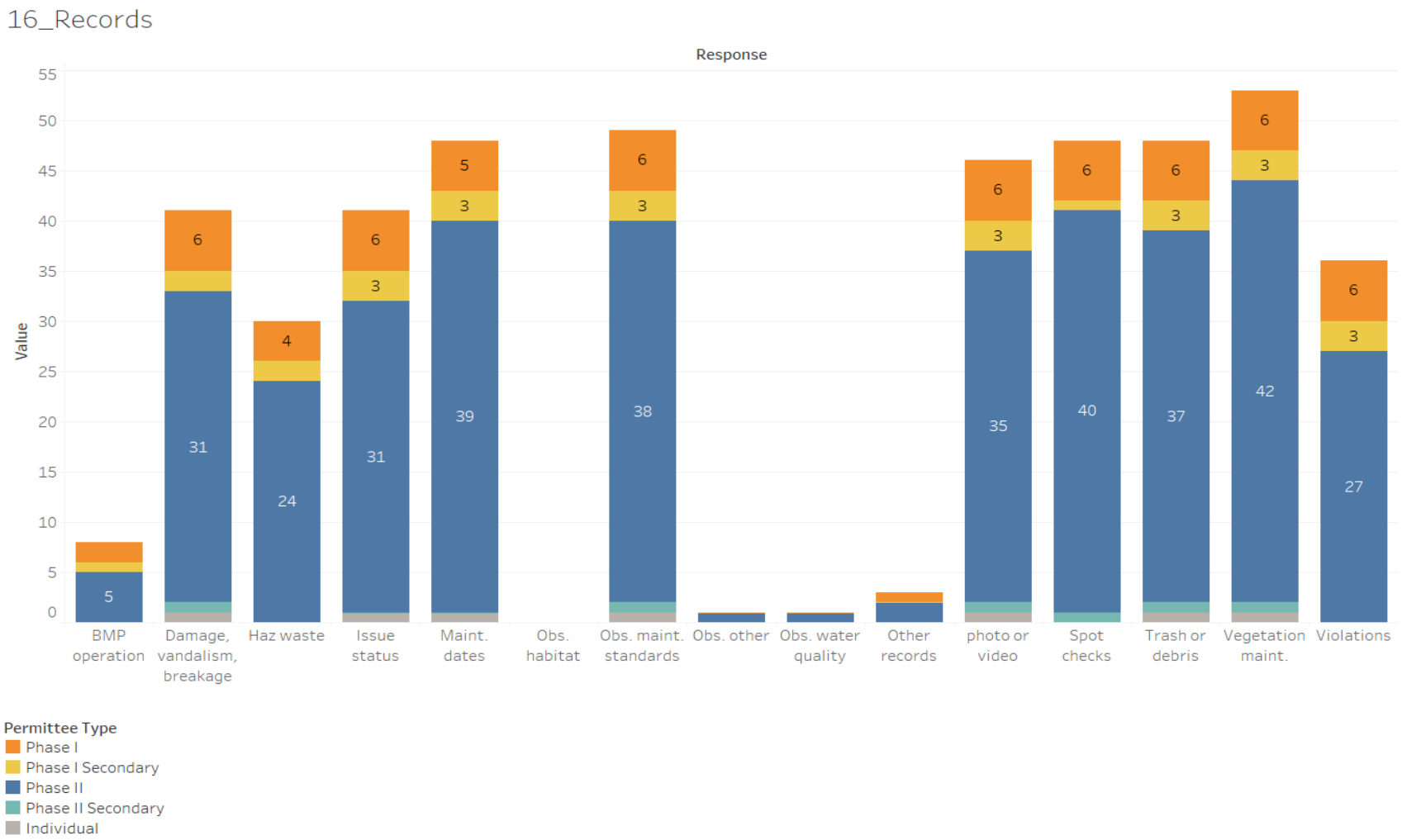

Figure 15
Maintenance Record-Keeping
Survey of Municipal Stormwater Operations and Maintenance
Project No. 200203
Stormwater O SAM Study

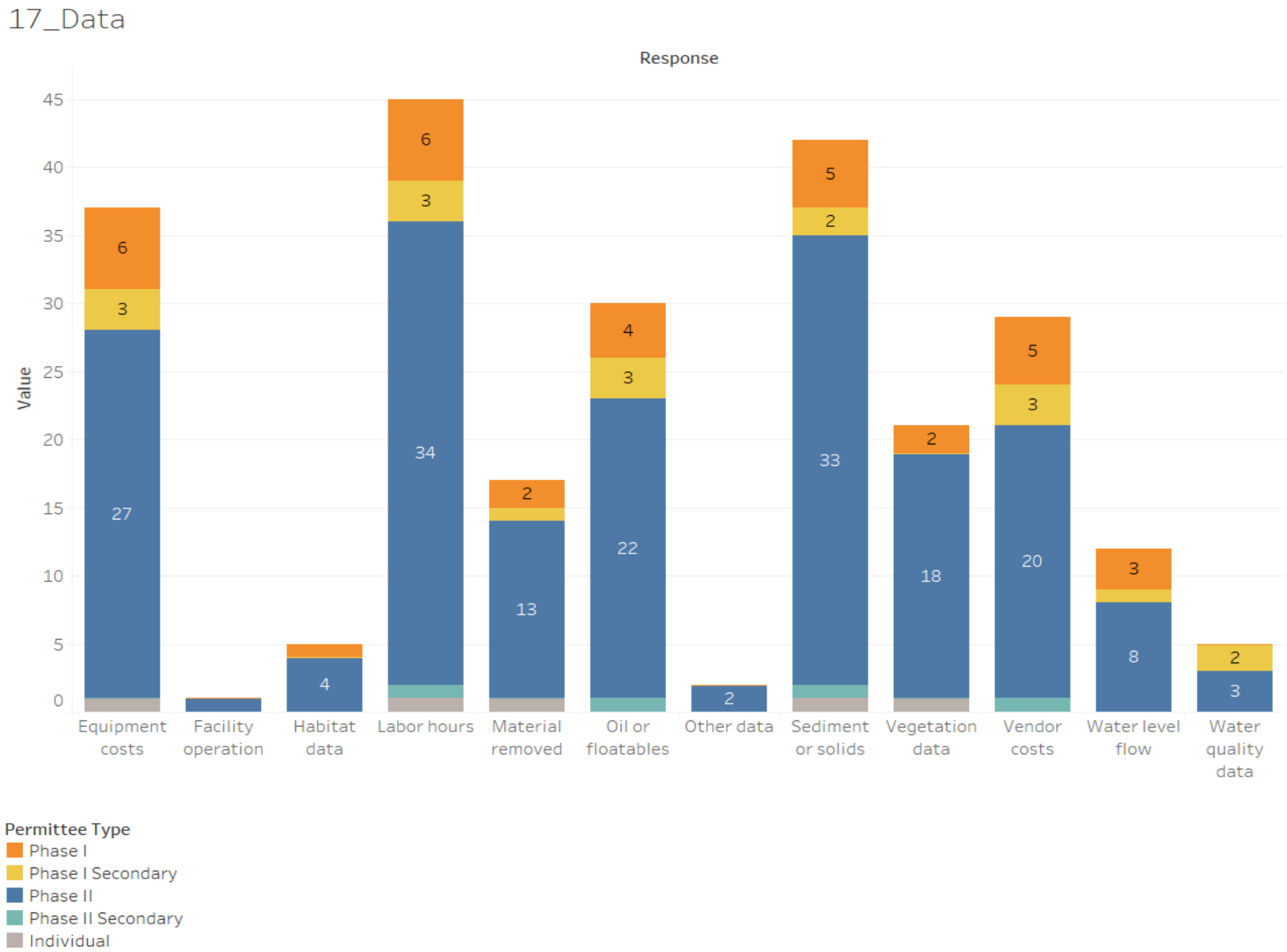

Figure 16
Maintenance Data Collected
Survey of Municipal Stormwater Operations and Maintenance
Project No. 200203
Stormwater O SAM Study

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APPENDIX A

Survey Questions

SURVEY of Western Washington Municipal Stormwater Permittees

SAM Study: Evaluation of BMP Operations and Maintenance Conditions

FINAL: 30 JUNE 2022

SURVEY QUESTIONS

1. What type of entity do you represent? (select one answer)
    1. Phase I municipal stormwater permittee
    2. Phase II municipal stormwater permittee
    3. Phase I Secondary permittee
    4. Phase II Secondary permittee
    5. Other_____

2. What jurisdiction do you represent (city, county, etc.)?

    (text answer)

3. How many staff perform O&M work on stormwater and water quality BMPs? Include staff from all departments (public works, parks, natural resources, etc.) who whose work includes some aspect of stormwater management using BMPs covered in the Stormwater Management Manual for Western Washington (SWMMWW) or equivalent. FTE = full-time equivalent. (select one answer)
    1. In-house staff: 0 to 1 FTEs
    2. In-house staff: 1.25 to 5 FTEs
    3. In-house staff: 5.25 to 10 FTEs
    4. In-house staff: 10.25 to 20 FTEs
    5. In-house staff: More than 20 FTEs
    6. Contractor/vendor (if applicable)

4. What is the approximate total annual budget for all stormwater-related O&M activities in your jurisdiction (including salaries)? Provide a round answer that reflects all departments and divisions. (select one answer)
    1. Less than $100,000
    2. $100,001-$250,000
    3. $250,001-$500,000
    4. $500,001-$1,000,000
    5. $1,000,001-$2,500,000
    6. $2,500,001-$5,000,000
    7. >$5,000,001
    8. Other_____

5. Considering this Study's focus on ponds, tanks, trenches, and vaults, which of the following BMP and facility types does your jurisdiction operate or maintain or regulate using the BMP Maintenance Tables (Appendix V-A BMP Maintenance Tables)? (select all that apply)

1. Pond: Detention/Wetpond
2. Pond: Infiltration/Bioretention
3. Pond: other
4. Tank: above ground
5. Tank: below ground
6. Tank: other
7. Trench: sand filtration
8. Trench: filter strips
9. Trench: infiltration trenches
10. Trench: biofiltration swale
11. Trench: other
12. Vault: detention/dry wetvault
13. Vault: sand filtration
14. Vault: other/manufactured filtration media
15. Vault: oil/water separators
16. Vault: other
17. Proprietary BMPs not listed here (categorized as ponds, tanks, trenches, or vaults)
18. None of the above

6. How many stormwater ponds (of all kinds) does your jurisdiction inspect and maintain through municipal programs? (select one answer)

1. 0
2. 1-5
3. 6-10
4. 11-20
5. 21+40
6. 41+

7. For stormwater ponds (of all kinds) what are the reasons for maintenance. (rank answers from most to least)

1. Sediment or trash removal
2. Vegetation management
3. Repair or adjustment of the facility
4. Active flooding or overflow
5. Complaint or public service request
6. Cleaning, dredging, or replacing media/soil
7. Habitat protection
8. Vandalism or facility protection
9. Spill response or clean-up
10. Animal-related issue (e.g. beaver dams)

8. How many stormwater trenches (of all kinds) does your jurisdiction maintain through municipal programs? (select one answer)

    1. 0
    2. 1-5
    3. 6-10
    4. 11-20
    5. 21+40
    6. 41+

9. For stormwater trenches (of all kinds) what are the reasons for maintenance. (rank answers from most to least)

    1. Sediment or trash removal
    2. Vegetation management
    3. Repair or adjustment of the facility
    4. Active flooding or overflow
    5. Complaint or public service request
    6. Cleaning, dredging, or replacing media/soil
    7. Habitat protection
    8. Vandalism or facility protection
    9. Spill response or clean-up
    10. Erosion or structural issues

10. How many stormwater vaults (of all kinds) does your jurisdiction maintain through municipal programs? (select one answer)

    1. 0
    2. 1-5
    3. 6-10
    4. 11-20
    5. 21+40
    6. 41+

11. For stormwater vaults (of all kinds) what are the reasons for maintenance. (rank answers from most to least)

    1. Sediment or trash removal
    2. Vegetation management
    3. Repair or adjustment of the facility
    4. Active flooding or overflow
    5. Complaint or public service request
    6. Cleaning, dredging, or replacing media/soil
    7. Habitat protection
    8. Vandalism or facility protection
    9. Spill response or clean-up
    10. Seepage or structural issues

12. How many tanks (of all kinds) does your jurisdiction maintain through municipal programs? (select one answer)

1. 0
2. 1-5
3. 6-10
4. 11-20
5. 21+40
6. 41+60
7. 61-100
8. 101+

13. For tanks (of all kinds) what are the reasons for maintenance. (rank answers from most to least)

1. Operational test
2. Cleaning
3. Ventilation issues
4. Damage assessment or repair
5. Replace parts/equipment
6. Complaint or public service request
7. Vandalism or facility protection
8. Spill response or clean-up
9. Seepage or structural issues

14. Overall, approximately what percentage of stormwater BMPs require maintenance following an inspection? (select one answer)

1. less than 10%
2. 11-25%
3. 26-50%
4. 51-75%
5. 76-100%

15. What guidance does your jurisdiction use to identify maintenance standards for stormwater BMPs and facilities regulated by your jurisdiction? Reference S5.C.7.a Phase II permit and S5.C.10.a Phase I permit. (select all that apply)

1. Ecology Stormwater Management Management Manual (western WA or eastern WA)
2. Your agency's own Stormwater Management Manual or other non-Ecology Manual
3. Stormwater Pollution Prevention Plans (SWPPPs) or other site-specific plans
4. Standard operating procedures for specific facilities or BMPs (including proprietary devices)
5. Documentation of "practices, policies, and procedures to reduce stormwater impacts" or other guidelines per Phase II S5.C7.d or Phase I S5.C.10.e.
6. General Operations and Maintenance Plan
7. Highway Runoff Manual (Washington DOT)
8. TAPE or other certification-based protocol
9. Field data from BMP inspections
10. Other_____

16. What type of maintenance records does your jurisdiction collect for stormwater BMP and facility inspections and O&M activities? (select all that apply)

1. Photographs or video
2. Observations or measurements associated with BMP maintenance standards
3. Observations of water quality
4. Observations of habitat (aquatic, terrestrial, etc.)
5. Other observations or measurements
6. Trash or debris presence
7. Hazardous waste presence
8. Vegetation maintenance activities
9. BMP functionality test
10. Maintenance dates or cycle
11. Spot checks
12. Damage, vandalism, or breakage of BMP or facility
13. Issue status (e.g. follow-up needed, resolved, etc.)
14. Violations, such as prohibited discharges or BMP usage inconsistent with municipal code
15. Other_____

17. What types of quantitative data are collected during stormwater BMP and facility O&M activities? (select all that apply)

1. Water level or depth or flow rate
2. Sediment or solids accumulation
3. Oil or floatables accumulation
4. Amount of material removed (waste, trash, debris, etc.)
5. Water quality data
6. Habitat data (aquatic, terrestrial, etc.)
7. Vegetation data (number of trees, shrubs, etc.)
8. BMP or facility maintenance frequency
9. Labor hours
10. Equipment costs
11. Vendor costs
12. Other_____

APPENDIX B

BMP Maintenance Tables, from SWMMWW Volume V, Appendix V-A

Appendix V-A: BMP Maintenance Tables

Ecology intends the facility-specific maintenance standards contained in this section to be conditions for determining if maintenance actions are required as identified through inspection. Recognizing that Permittees have limited maintenance funds and time, Ecology does not require that a Permittee perform all these maintenance activities on all their stormwater BMPs. We leave the determination of importance of each maintenance activity and its priority within the stormwater program to the Permittee. We do expect, however, that sufficient maintenance will occur to ensure that the BMPs continue to operate as designed to protect ground and surface waters.

Ecology doesn't intend that these measures identify the facility's required condition at all times between inspections. In other words, exceedance of these conditions at any time between inspections and/or maintenance does not automatically constitute a violation of these standards. However, based upon inspection observations, the Permittee shall adjust inspection and maintenance schedules to minimize the length of time that a facility is in a condition that requires a maintenance action.

Table V-A.1: Maintenance Standards - Detention Ponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash & Debris	Any trash and debris which exceed 1 cubic feet per 1,000 square feet. In general, there should be no visual evidence of dumping. If less than threshold all trash and debris will be removed as part of next scheduled maintenance.	Trash and debris cleared from site
	Poisonous Vegetation and noxious weeds	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by State or local regulations. (Apply requirements of adopted IPM policies for the use of herbicides).	No danger of poisonous vegetation where maintenance personnel or the public might normally be. (Coordinate with local health department) Complete eradication of noxious weeds may not be possible. Compliance with State or local eradication policies required
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants (Coordinate removal/cleanup with local water quality response agency).	No contaminants or pollutants present.

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
	Rodent Holes	Any evidence of rodent holes if facility is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Rodents destroyed and dam or berm repaired. (Coordinate with local health department; coordinate with Ecology Dam Safety Office if pond exceeds 10 acre-feet.)
	Beaver Dams	Dam results in change or function of the facility.	Facility is returned to design function. (Coordinate trapping of beavers and removal of dams with appropriate permitting agencies)
	Insects	When insects such as wasps and hornets interfere with maintenance activities.	Insects destroyed or removed from site. Apply insecticides in compliance with adopted IPM policies
	Tree Growth and Hazard Trees	Tree growth does not allow maintenance and inspection access or interferes with maintenance activity (i.e., slope mowing, silt removal, vactoring, or equipment movements). If trees are not interfering with access or maintenance, do not remove If dead, diseased, or dying trees are identified (Use a certified Arborist to determine health of tree or removal requirements)	Trees do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g., alders for firewood). Remove hazard Trees
Side Slopes of Pond	Erosion	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion. Any erosion observed on a compacted berm embankment.	Slopes should be stabilized using appropriate erosion control measure(s); e.g.,rock reinforcement, planting of grass, compaction. If erosion is occurring on compacted berms a licensed engineer in the state of Washington should be consulted to resolve source of erosion.
Storage Area	Sediment	Accumulated sediment that exceeds 10% of the designed pond depth unless otherwise specified or affects inletting or outletting condition of the facility.	Sediment cleaned out to designed pond shape and depth; pond reseeded if necessary to control erosion.
	Liner (if Applicable)	Liner is visible and has more than three 1/4-inch holes in it.	Liner repaired or replaced. Liner is fully covered.

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Ponds Berms (Dikes)	Settlements	Any part of berm which has settled 4 inches lower than the design elevation If settlement is apparent, measure berm to determine amount of settlement Settling can be an indication of more severe problems with the berm or outlet works. A licensed engineer in the state of Washington should be consulted to determine the source of the settlement.	Dike is built back to the design elevation.
	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Goethechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.
Emergency Overflow/ Spillway and Berms over 4 feet in height	Tree Growth	Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping. Tree growth on berms over 4 feet in height may lead to piping through the berm which could lead to failure of the berm.	Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A licensed engineer in the state of Washington should be consulted for proper berm/spillway restoration.
	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Geotechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.
Emergency Overflow/Spillway	Emergency Overflow/Spillway	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil at the top of out flow path of spillway. (Rip-rap on inside slopes need not be replaced.)	Rocks and pad depth are restored to design standards.
	Erosion	See "Side Slopes of Pond"	

Table V-A.2: Maintenance Standards - Infiltration

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash & Debris	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
	Poisonous/Noxious Vegetation	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
	Contaminants and Pollution	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
	Rodent Holes	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
Storage Area	Sediment	Water ponding in infiltration pond after rainfall ceases and appropriate time allowed for infiltration. Treatment basins should infiltrate Water Quality Design Storm Volume within 48 hours, and empty within 24 hours after cessation of most rain events. (A percolation test pit or test of facility indicates facility is only working at 90% of its designed capabilities. Test every 2 to 5 years. If two inches or more sediment is present, remove).	Sediment is removed and/or facility is cleaned so that infiltration system works according to design.
Filter Bags (if applicable)	Filled with Sediment and Debris	Sediment and debris fill bag more than 1/2 full.	Filter bag is replaced or system is redesigned.
Rock Filters	Sediment and Debris	By visual inspection, little or no water flows through filter during heavy rain storms.	Gravel in rock filter is replaced.
Side Slopes of Pond	Erosion	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
Emergency Overflow Spillway and Berms over 4 feet in height.	Tree Growth	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
	Piping	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Emergency Overflow Spillway	Rock Missing	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
	Erosion	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
Pre-settling Ponds and Vaults	Facility or sump filled with Sediment and/or debris	6" or designed sediment trap depth of sediment.	Sediment is removed.

Table V-A.3: Maintenance Standards - Closed Detention Systems (Tanks/Vaults)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Storage Area	Plugged Air Vents	One-half of the cross section of a vent is blocked at any point or the vent is damaged.	Vents open and functioning.
	Debris and Sediment	Accumulated sediment depth exceeds 10% of the diameter of the storage area for 1/2 length of storage vault or any point depth exceeds 15% of diameter. (Example: 72-inch storage tank would require cleaning when sediment reaches depth of 7 inches for more than 1/2 length of tank.)	All sediment and debris removed from storage area.
	Joints Between Tank/Pipe Section	Any openings or voids allowing material to be transported into facility. (Will require engineering analysis to determine structural stability).	All joint between tank/pipe sections are sealed.
	Tank Pipe Bent Out of Shape	Any part of tank/pipe is bent out of shape more than 10% of its design shape. (Review required by engineer to determine structural stability).	Tank/pipe repaired or replaced to design.
	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch and any evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determines that the vault is not structurally sound. Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or any evidence of soil particles entering the vault through the walls.	Vault replaced or repaired to design specifications and is structurally sound. No cracks more than 1/4-inch wide at the joint of the inlet/outlet pipe.
Manhole	Cover Not in Place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole is closed.

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread (may not apply to self-locking lids).	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person.
	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, misalignment, not securely attached to structure wall, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.
Catch Basins	See Table V-A.5: Maintenance Standards - Catch Basins	See Table V-A.5: Maintenance Standards - Catch Basins	See Table V-A.5: Maintenance Standards - Catch Basins

Table V-A.4: Maintenance Standards - Control Structure/Flow Restrictor

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris (Includes Sediment)	Material exceeds 25% of sump depth or 1 foot below orifice plate.	Control structure orifice is not blocked. All trash and debris removed.
	Structural Damage	Structure is not securely attached to manhole wall. Structure is not in upright position (allow up to 10% from plumb). Connections to outlet pipe are not watertight and show signs of rust. Any holes - other than designed holes - in the structure.	Structure securely attached to wall and outlet pipe. Structure in correct position. Connections to outlet pipe are water tight; structure repaired or replaced and works as designed. Structure has no holes other than designed holes.

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Cleanout Gate	Damaged or Missing	Cleanout gate is not watertight or is missing. Gate cannot be moved up and down by one maintenance person. Chain/rod leading to gate is missing or damaged. Gate is rusted over 50% of its surface area.	Gate is watertight and works as designed. Gate moves up and down easily and is watertight. Chain is in place and works as designed. Gate is repaired or replaced to meet design standards.
Orifice Plate	Damaged or Missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
Overflow Pipe	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
Manhole	See Table V-A.3: Maintenance Standards - Closed Detention Systems (Tanks/Vaults)	See Table V-A.3: Maintenance Standards - Closed Detention Systems (Tanks/Vaults)	See Table V-A.3: Maintenance Standards - Closed Detention Systems (Tanks/Vaults)
Catch Basin	See Table V-A.5: Maintenance Standards - Catch Basins	See Table V-A.5: Maintenance Standards - Catch Basins	See Table V-A.5: Maintenance Standards - Catch Basins

Table V-A.5: Maintenance Standards - Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
General	Trash & Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%. Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe. Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height. Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No Trash or debris located immediately in front of catch basin or on grate opening. No trash or debris in the catch basin. Inlet and outlet pipes free of trash or debris. No dead animals or vegetation present within the catch basin.

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch. (Intent is to make sure no material is running into basin). Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached	Top slab is free of holes and cracks. Frame is sitting flush on the riser rings or top slab and firmly attached.
	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound. Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Basin replaced or repaired to design standards. Pipe is regrouted and secure at basin wall.
	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
	Vegetation	Vegetation growing across and blocking more than 10% of the basin opening. Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation blocking opening to basin. No vegetation or root growth present.
	Contamination and Pollution	See Table V-A.1: Maintenance Standards - Detention Ponds	No pollution present.
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Cover/grate is in place, meets design standards, and is secured
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread.	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. (Intent is keep cover from sealing off access to maintenance.)	Cover can be removed by one maintenance person.

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
Ladder	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, not securely attached to basin wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
Metal Grates (If Applicable)	Grate opening Unsafe	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing.	Grate missing or broken member(s) of the grate.	Grate is in place, meets the design standards, and is installed and aligned with the flow path.

Table V-A.6: Maintenance Standards - Debris Barriers (e.g., Trash Racks)

Maintenance Components	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris	Trash or debris that is plugging more than 20% of the openings in the barrier.	Barrier cleared to design flow capacity.
Metal	Damaged/ Missing Bars.	Bars are bent out of shape more than 3 inches. Bars are missing or entire barrier missing. Bars are loose and rust is causing 50% deterioration to any part of barrier.	Bars in place with no bends more than 3/4 inch. Bars in place according to design. Barrier replaced or repaired to design standards.
	Inlet/Outlet Pipe	Debris barrier missing or not attached to pipe	Barrier firmly attached to pipe

Table V-A.7: Maintenance Standards - Energy Dissipators

Maintenance Components	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
External:			

Maintenance Components	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Rock Pad	Missing or Moved Rock	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil.	Rock pad replaced to design standards.
	Erosion	Soil erosion in or adjacent to rock pad.	Rock pad replaced to design standards.
Dispersion Trench	Pipe Plugged with Sediment	Accumulated sediment that exceeds 20% of the design depth.	Pipe cleaned/flushed so that it matches design.
	Not Discharging Water Properly	Visual evidence of water discharging at concentrated points along trench (normal condition is a "sheet flow"□ of water along trench). Intent is to prevent erosion damage.	Trench redesigned or rebuilt to standards.
	Perforations Plugged.	Over 1/2 of perforations in pipe are plugged with debris and sediment.	Perforated pipe cleaned or replaced.
	Water Flows Out Top of "Distributor" Catch Basin.	Maintenance person observes or receives credible report of water flowing out during any storm less than the design storm or its causing or appears likely to cause damage.	Facility rebuilt or redesigned to standards.
	Receiving Area Over-Saturated	Water in receiving area is causing or has potential of causing landslide problems.	No danger of landslides.
Internal:			
Manhole/Chamber	Worn or Damaged Post, Baffles, Side of Chamber	Structure dissipating flow deteriorates to 1/2 of original size or any concentrated worn spot exceeding one square foot which would make structure unsound.	Structure replaced to design standards.
	Other Defects	See Table V-A.5: Maintenance Standards - Catch Basins	See Table V-A.5: Maintenance Standards - Catch Basins

Table V-A.8: Maintenance Standards - Typical Biofiltration Swale

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation on Grass	Sediment depth exceeds 2 inches.	Remove sediment deposits on grass treatment area of the bio-swale. When finished, swale should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased.
	Standing Water	When water stands in the swale between storms and does not drain freely.	Any of the following may apply: remove sediment or trash blockages, improve grade from head to foot of swale, remove clogged check dams, add underdrains or convert to a wet biofiltration swale.
	Flow spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire swale width.	Level the spreader and clean so that flows are spread evenly over entire swale width.
	Constant Baseflow	When small quantities of water continually flow through the swale, even when it has been dry for weeks, and an eroded, muddy channel has formed in the swale bottom.	Add a low-flow pea-gravel drain the length of the swale or by-pass the baseflow around the swale.
	Poor Vegetation Coverage	When grass is sparse or bare or eroded patches occur in more than 10% of the swale bottom.	Determine why grass growth is poor and correct that condition. Re-plant with plugs of grass from the upper slope: plant in the swale bottom at 8-inch intervals. Or re-seed into loosened, fertile soil.
	Vegetation	When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Mow vegetation or remove nuisance vegetation so that flow not impeded. Grass should be mowed to a height of 3 to 4 inches. Remove grass clippings.
	Excessive Shading	Grass growth is poor because sunlight does not reach swale.	If possible, trim back over-hanging limbs and remove brushy vegetation on adjacent slopes.
	Inlet/Outlet	Inlet/outlet areas clogged with sediment and/or debris.	Remove material so that there is no clogging or blockage in the inlet and outlet area.
	Trash and Debris Accumulation	Trash and debris accumulated in the bio-swale.	Remove trash and debris from bioswale.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
	Erosion/Scouring	Eroded or scoured swale bottom due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. If bare areas are large, generally greater than 12 inches wide, the swale should be re-graded and re-seeded. For smaller bare areas, overseed when bare spots are evident, or take plugs of grass from the upper slope and plant in the swale bottom at 8-inch intervals.

Table V-A.9: Maintenance Standards - Wet Biofiltration Swale

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation	Sediment depth exceeds 2-inches in 10% of the swale treatment area.	Remove sediment deposits in treatment area.
	Water Depth	Water not retained to a depth of about 4 inches during the wet season.	Build up or repair outlet berm so that water is retained in the wet swale.
	Wetland Vegetation	Vegetation becomes sparse and does not provide adequate filtration, OR vegetation is crowded out by very dense clumps of cattail, which do not allow water to flow through the clumps.	Determine cause of lack of vigor of vegetation and correct. Replant as needed. For excessive cattail growth, cut cattail shoots back and compost off-site. Note: normally wetland vegetation does not need to be harvested unless die-back is causing oxygen depletion in downstream waters.
	Inlet/Outlet	Inlet/outlet area clogged with sediment and/or debris.	Remove clogging or blockage in the inlet and outlet areas.
	Trash and Debris Accumulation	See Table V-A.1: Maintenance Standards - Detention Ponds	Remove trash and debris from wet swale.
	Erosion/Scouring	Swale has eroded or scoured due to flow channelization, or higher flows.	Check design flows to assure swale is large enough to handle flows. By-pass excess flows or enlarge swale. Replant eroded areas with fibrous-rooted plants such as Juncus effusus (soft rush) in wet areas or snowberry (Symphoricarpos albus) in dryer areas.

Table V-A.10: Maintenance Standards - Filter Strips

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation on Grass	Sediment depth exceeds 2 inches.	Remove sediment deposits, re-level so slope is even and flows pass evenly through strip.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
	Vegetation	When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Mow grass, control nuisance vegetation, such that flow not impeded. Grass should be mowed to a height between 3-4 inches.
	Trash and Debris Accumulation	Trash and debris accumulated on the filter strip.	Remove trash and Debris from filter.
	Erosion/Scouring	Eroded or scoured areas due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. The grass will creep in over the rock in time. If bare areas are large, generally greater than 12 inches wide, the filter strip should be re-graded and re-seeded. For smaller bare areas, overseed when bare spots are evident.
	Flow spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire filter width.	Level the spreader and clean so that flows are spread evenly over entire filter width.

Table V-A.11: Maintenance Standards - Wetponds

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Water level	First cell is empty, doesn't hold water.	Line the first cell to maintain at least 4 feet of water. Although the second cell may drain, the first cell must remain full to control turbulence of the incoming flow and reduce sediment resuspension.
	Trash and Debris	Accumulation that exceeds 1 CF per 1000-SF of pond area.	Trash and debris removed from pond.
	Inlet/Outlet Pipe	Inlet/Outlet pipe clogged with sediment and/or debris material.	No clogging or blockage in the inlet and outlet piping.
	Sediment Accumulation in Pond Bottom	Sediment accumulations in pond bottom that exceeds the depth of sediment zone plus 6-inches, usually in the first cell.	Sediment removed from pond bottom.

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
	Oil Sheen on Water	Prevalent and visible oil sheen.	Oil removed from water using oil-absorbent pads or vactor truck. Source of oil located and corrected. If chronic low levels of oil persist, plant wetland plants such as Juncus effusus (soft rush) which can uptake small concentrations of oil.
	Erosion	Erosion of the pond's side slopes and/or scouring of the pond bottom, that exceeds 6-inches, or where continued erosion is prevalent.	Slopes stabilized using proper erosion control measures and repair methods.
	Settlement of Pond Dike/Berm	Any part of these components that has settled 4-inches or lower than the design elevation, or inspector determines dike/berm is unsound.	Dike/berm is repaired to specifications.
	Internal Berm	Berm dividing cells should be level.	Berm surface is leveled so that water flows evenly over entire length of berm.
	Overflow Spillway	Rock is missing and soil is exposed at top of spillway or outside slope.	Rocks replaced to specifications.

Table V-A.12: Maintenance Standards - Wetvaults

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash/Debris Accumulation	Trash and debris accumulated in vault, pipe or inlet/outlet (includes floatables and non-floatables).	Remove trash and debris from vault.
	Sediment Accumulation in Vault	Sediment accumulation in vault bottom exceeds the depth of the sediment zone plus 6-inches.	Remove sediment from vault.
	Damaged Pipes	Inlet/outlet piping damaged or broken and in need of repair.	Pipe repaired and/or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened or removed, especially by one person.	Cover repaired or replaced to proper working specifications.
	Ventilation	Ventilation area blocked or plugged.	Blocking material removed or cleared from ventilation area. A specified % of the vault surface area must provide ventilation to the vault interior (see design specifications).

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
	Vault Structure Damage - Includes Cracks in Walls Bottom, Damage to Frame and/or Top Slab	Maintenance/inspection personnel determine that the vault is not structurally sound. Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound. Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection staff.	Baffles repaired or replaced to specifications.
	Access Ladder Damage	Ladder is corroded or deteriorated, not functioning properly, not attached to structure wall, missing rungs, has cracks and/or misaligned. Confined space warning sign missing.	Ladder replaced or repaired to specifications, and is safe to use as determined by inspection personnel. Replace sign warning of confined space entry requirements. Ladder and entry notification complies with OSHA standards.

Table V-A.13: Maintenance Standards - Sand Filters (Above Ground/Open)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Above Ground (open sand filter)	Sediment Accumulation on top layer	Sediment depth exceeds 1/2-inch.	No sediment deposit on grass layer of sand filter that would impede permeability of the filter section.
	Trash and Debris Accumulations	Trash and debris accumulated on sand filter bed.	Trash and debris removed from sand filter bed.
	Sediment/ Debris in Clean-Outs	When the clean-outs become full or partially plugged with sediment and/or debris.	Sediment removed from clean-outs.
	Sand Filter Media	Drawdown of water through the sand filter media takes longer than 24-hours, and/or flow through the overflow pipes occurs frequently.	Top several inches of sand are scraped. May require replacement of entire sand filter depth depending on extent of plugging (a sieve analysis is helpful to determine if the lower sand has too high a proportion of fine material).
	Prolonged Flows	Sand is saturated for prolonged periods of time (several weeks) and does not dry out between storms due to continuous base flow or prolonged flows from detention facilities.	Low, continuous flows are limited to a small portion of the facility by using a low wooden divider or slightly depressed sand surface.

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
	Short Circuiting	When flows become concentrated over one section of the sand filter rather than dispersed.	Flow and percolation of water through sand filter is uniform and dispersed across the entire filter area.
	Erosion Damage to Slopes	Erosion over 2-inches deep where cause of damage is prevalent or potential for continued erosion is evident.	Slopes stabilized using proper erosion control measures.
	Rock Pad Missing or Out of Place	Soil beneath the rock is visible.	Rock pad replaced or rebuilt to design specifications.
	Flow Spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed across sand filter.	Spreader leveled and cleaned so that flows are spread evenly over sand filter.
	Damaged Pipes	Any part of the piping that is crushed or deformed more than 20% or any other failure to the piping.	Pipe repaired or replaced.

Table V-A.14: Maintenance Standards - Sand Filters (Below Ground/Enclosed)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Below Ground Vault.	Sediment Accumulation on Sand Media Section	Sediment depth exceeds 1/2-inch.	No sediment deposits on sand filter section that which would impede permeability of the filter section.
	Sediment Accumulation in Pre-Settling Portion of Vault	Sediment accumulation in vault bottom exceeds the depth of the sediment zone plus 6-inches.	No sediment deposits in first chamber of vault.
	Trash/Debris Accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault and inlet/outlet piping.
	Sediment in Drain Pipes/Cleanouts	When drain pipes, cleanouts become full with sediment and/or debris.	Sediment and debris removed.
	Short Circuiting	When seepage/flow occurs along the vault walls and corners. Sand eroding near inflow area.	Sand filter media section re-laid and compacted along perimeter of vault to form a semi-seal. Erosion protection added to dissipate force of incoming flow and curtail erosion.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and/or replaced.

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
	Access Cover Damaged/Not Working	Cover cannot be opened, corrosion/deformation of cover. Maintenance person cannot remove cover using normal lifting pressure.	Cover repaired to proper working specifications or replaced.
	Ventilation	Ventilation area blocked or plugged	Blocking material removed or cleared from ventilation area. A specified % of the vault surface area must provide ventilation to the vault interior (see design specifications).
	Vault Structure Damaged; Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab.	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound. Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound. Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles/Internal walls	Baffles or walls corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired to specifications, and is safe to use as determined by inspection personnel.

Table V-A.15: Maintenance Standards - Manufactured Media Filters

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Below Ground Vault	Sediment Accumulation on Media.	Sediment depth exceeds 0.25-inches.	No sediment deposits which would impede permeability of the compost media.
	Sediment Accumulation in Vault	Sediment depth exceeds 6-inches in first chamber.	No sediment deposits in vault bottom of first chamber.
	Trash/Debris Accumulation	Trash and debris accumulated on compost filter bed.	Trash and debris removed from the compost filter bed.
	Sediment in Drain Pipes/Clean-Outs	When drain pipes, clean-outs, become full with sediment and/or debris.	Sediment and debris removed.

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
	Damaged Pipes	Any part of the pipes that are crushed or damaged due to corrosion and/or settlement.	Pipe repaired and/or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened; one person cannot open the cover using normal lifting pressure, corrosion/deformation of cover.	Cover repaired to proper working specifications or replaced.
	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound. Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound. Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles	Baffles corroding, cracking warping, and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.
Below Ground Cartridge Type	Media	Drawdown of water through the media takes longer than 1 hour, and/or overflow occurs frequently.	Media cartridges replaced.
	Short Circuiting	Flows do not properly enter filter cartridges.	Filter cartridges replaced.

Table V-A.16: Maintenance Standards - Baffle Oil/Water Separators (API Type)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Monitoring	Inspection of discharge water for obvious signs of poor water quality.	Effluent discharge from vault should be clear with out thick visible sheen.
	Sediment Accumulation	Sediment depth in bottom of vault exceeds 6-inches in depth.	No sediment deposits on vault bottom that would impede flow through the vault and reduce separation efficiency.
	Trash and Debris Accumulation	Trash and debris accumulation in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault, and inlet/outlet piping.

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
	Oil Accumulation	Oil accumulations that exceed 1-inch, at the surface of the water.	Extract oil from vault by vactoring. Disposal in accordance with state and local rules and regulations.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened, corrosion/deformation of cover.	Cover repaired to proper working specifications or replaced.
	Vault Structure Damage - Includes Cracks in Walls Bottom, Damage to Frame and/or Top Slab	See Table V-A.5: Maintenance Standards - Catch Basins Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound. Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

Table V-A.17: Maintenance Standards - Coalescing Plate Oil/Water Separators

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Monitoring	Inspection of discharge water for obvious signs of poor water quality.	Effluent discharge from vault should be clear with no thick visible sheen.
	Sediment Accumulation	Sediment depth in bottom of vault exceeds 6-inches in depth and/or visible signs of sediment on plates.	No sediment deposits on vault bottom and plate media, which would impede flow through the vault and reduce separation efficiency.
	Trash and Debris Accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault, and inlet/outlet piping.
	Oil Accumulation	Oil accumulation that exceeds 1-inch at the water surface.	Oil is extracted from vault using vactoring methods. Coalescing plates are cleaned by thoroughly rinsing and flushing. Should be no visible oil depth on water.

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
	Damaged Coalescing Plates	Plate media broken, deformed, cracked and/or showing signs of failure.	A portion of the media pack or the entire plate pack is replaced depending on severity of failure.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and or replaced.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Vault Structure Damage - Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound. Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound. Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

Table V-A.18: Maintenance Standards - Catch Basin Inserts

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Sediment Accumulation	When sediment forms a cap over the insert media of the insert and/or unit.	No sediment cap on the insert media and its unit.
	Trash and Debris Accumulation	Trash and debris accumulates on insert unit creating a blockage/restriction.	Trash and debris removed from insert unit. Runoff freely flows into catch basin.
	Media Insert Not Removing Oil	Effluent water from media insert has a visible sheen.	Effluent water from media insert is free of oils and has no visible sheen.
	Media Insert Water Saturated	Catch basin insert is saturated with water and no longer has the capacity to absorb.	Remove and replace media insert
	Media Insert-Oil Saturated	Media oil saturated due to petroleum spill that drains into catch basin.	Remove and replace media insert.
	Media Insert Use Beyond Product Life	Media has been used beyond the typical average life of media insert product.	Remove and replace media at regular intervals, depending on insert product.

Table V-A.19: Maintenance Standards - Media Filter Drain (MFD)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Sediment accumulation on grass filter strip	Sediment depth exceeds 2 inches or creates uneven grading that interferes with sheet flow.	Remove sediment deposits on grass treatment area of the embankment. When finished, embankment should be level from side to side and drain freely toward the toe of the embankment slope. There should be no areas of standing water once inflow has ceased.
	No-vegetation zone/flow spreader	Flow spreader is uneven or clogged so that flows are not uniformly distributed over entire embankment width.	Level the spreader and clean to spread flows evenly over entire embankment width.
	Poor vegetation coverage	Grass is sparse or bare, or eroded patches are observed in more than 10% of the grass strip surface area.	Determine why grass growth is poor and correct the offending condition. Reseed into loosened, fertile soil or compost; or, replant with plugs of grass from the upper slope.
	Vegetation	Grass becomes excessively tall (greater than 10 inches); nuisance weeds and other vegetation start to take over.	Mow vegetation or remove nuisance vegetation to not impede flow. Mow grass to a height of 6 inches.
	Media filter drain mix replacement	Water is seen on the surface of the media filter drain mix long after the storms have ceased. Typically, the 6-month, 24-hour precipitation event should drain within 48 hours. More common storms should drain within 24 hours. Maintenance also needed on a 10-year cycle and during a preservation project.	Excavate and replace all of the media filter drain mix contained within the media filter drain.
	Excessive shading	Grass growth is poor because sunlight does not reach embankment.	If possible, trim back overhanging limbs and remove brushy vegetation on adjacent slopes.
	Trash and debris	Trash and debris have accumulated on embankment.	Remove trash and debris from embankment.
	Flooding of Media filter drain	When media filter drain is inundated by flood water	Evaluate media filter drain material for acceptable infiltration rate and replace if media filter drain does not meet long-term infiltration rate standards.

Table V-A.20: Maintenance Standards - Compost Amended Vegetated Filter Strip (CAVFS)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Sediment accumulation on grass	Sediment depth exceeds 2 inches.	Remove sediment deposits. Relevel so slope is even and flows pass evenly through strip.
	Vegetation	Grass becomes excessively tall (greater than 10 inches); nuisance weeds and other vegetation start to take over.	Mow grass and control nuisance vegetation so that flow is not impeded. Grass should be mowed to a height of 6 inches.
	Trash and debris	Trash and debris have accumulated on the vegetated filter strip.	Remove trash and debris from filter.
	Erosion/scouring	Areas have eroded or scoured due to flow channelization or high flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with a 50/50 mixture of crushed gravel and compost. The grass will creep in over the rock in time. If bare areas are large, generally greater than 12 inches wide, the vegetated filter strip should be regraded and reseeded. For smaller bare areas, overseed when bare spots are evident.
	Flow spreader	Flow spreader is uneven or clogged so that flows are not uniformly distributed over entire filter width.	Level the spreader and clean so that flows are spread evenly over entire filter width

Table V-A.21: Maintenance Standards - Bioretention Facilities

Maintenance Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Facility Footprint				

Maintenance Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Earthen side slopes and berms	B, S		Erosion (gullies/ rills) greater than 2 inches deep around inlets, outlet, and alongside slopes	• Eliminate cause of erosion and stabilize damaged area (regrade, rock, vegetation, erosion control matting) • For deep channels or cuts (over 3 inches in ponding depth), temporary erosion control measures should be put in place until permanent repairs can be made. • Properly designed, constructed and established facilities with appropriate flow velocities should not have erosion problems except perhaps in extreme events. If erosion problems persist, the following should be reassessed: (1) flow volumes from contributing areas and bioretention facility sizing; (2) flow velocities and gradients within the facility; and (3) flow dissipation and erosion protection strategies at the facility inlet.
	A		Erosion of sides causes slope to become a hazard	Take actions to eliminate the hazard and stabilize slopes
	A, S		Settlement greater than 3 inches (relative to undisturbed sections of berm)	Restore to design height
	A, S		Downstream face of berm wet, seeps or leaks evident	Plug any holes and compact berm (may require consultation with engineer, particularly for larger berms)
	A		Any evidence of rodent holes or water piping in berm	• Eradicate rodents (see "Pest control") • Fill holes and compact (may require consultation with engineer, particularly for larger berms)
Concrete sidewalls	A		Cracks or failure of concrete sidewalls	• Repair/ seal cracks • Replace if repair is insufficient
Rockery sidewalls	A		Rockery side walls are insecure	Stabilize rockery sidewalls (may require consultation with engineer, particularly for walls 4 feet or greater in height)

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Facility area		All maintenance visits (at least biannually)	Trash and debris present	Clean out trash and debris
Facility bottom area	A, S		Accumulated sediment to extent that infiltration rate is reduced (see "Ponded water") or surface storage capacity significantly impacted	• Remove excess sediment • Replace any vegetation damaged or destroyed by sediment accumulation and removal • Mulch newly planted vegetation • Identify and control the sediment source (if feasible) • If accumulated sediment is recurrent, consider adding presettlement or installing berms to create a forebay at the inlet
		During/after fall leaf drop	Accumulated leaves in facility	Remove leaves if there is a risk to clogging outlet structure or water flow is impeded
Low permeability check dams and weirs	A, S		Sediment, vegetation, or debris accumulated at or blocking (or having the potential to block) check dam, flow control weir or orifice	Clear the blockage
	A, S		Erosion and/or undercutting present	Repair and take preventative measures to prevent future erosion and/or undercutting
	A		Grade board or top of weir damaged or not level	Restore to level position

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Ponded water	B, S		Excessive ponding water: Water overflows during storms smaller than the design event or ponded water remains in the basin 48 hours or longer after the end of a storm.	Determine cause and resolve in the following order: 1. Confirm leaf or debris buildup in the bottom of the facility is not impeding infiltration. If necessary, remove leaf litter/debris. 2. Ensure that underdrain (if present) is not clogged. If necessary, clear underdrain. 3. Check for other water inputs (e.g., groundwater, illicit connections). 4. Verify that the facility is sized appropriately for the contributing area. Confirm that the contributing area has not increased. If steps #1-4 do not solve the problem, the bioretention soil is likely clogged by sediment accumulation at the surface or has become overly compacted. Dig a small hole to observe soil profile and identify compaction depth or clogging front to help determine the soil depth to be removed or otherwise rehabilitated (e.g., tilled). Consultation with an engineer is recommended.

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Bioretention soil mix	As needed		Bioretention soil mix protection is needed when performing maintenance requiring entrance into the facility footprint	• Minimize all loading in the facility footprint (foot traffic and other loads) to the degree feasible in order to prevent compaction of bioretention soils. • Never drive equipment or apply heavy loads in facility footprint. • Because the risk of compaction is higher during saturated soil conditions, any type of loading in the cell (including foot traffic) should be minimized during wet conditions. • Consider measures to distribute loading if heavy foot traffic is required or equipment must be placed in facility. As an example, boards may be placed across soil to distribute loads and minimize compaction. • If compaction occurs, soil must be loosened or otherwise rehabilitated to original design state.
Inlets/Outlets/Pipes				
Splash block inlet	A		Water is not being directed properly to the facility and away from the inlet structure	Reconfigure/ repair blocks to direct water to facility and away from structure
Curb cut inlet/outlet	M during the wet season and before severe storm is forecasted	Weekly during fall leaf drop	Accumulated leaves at curb cuts	Clear leaves (particularly important for key inlets and low points along long, linear facilities)
Pipe inlet/outlet	A		Pipe is damaged	Repair/ replace
	W		Pipe is clogged	Remove roots or debris
	A, S		Sediment, debris, trash, or mulch reducing capacity of inlet/outlet	• Clear the blockage • Identify the source of the blockage and take actions to prevent future blockages
		Weekly during fall leaf drop	Accumulated leaves at inlets/outlets	Clear leaves (particularly important for key inlets and low points along long, linear facilities)

Maintenance Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
		A	Maintain access for inspections	• Clear vegetation (transplant vegetation when possible) within 1 foot of inlets and outlets, maintain access pathways • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
Erosion control at inlet	A		Concentrated flows are causing erosion	Maintain a cover of rock or cobbles or other erosion protection measure (e.g., matting) to protect the ground where concentrated water enters the facility (e.g., a pipe, curb cut or swale)
Trash rack	S		Trash or other debris present on trash rack	Remove/dispose
	A		Bar screen damaged or missing	Repair/replace
Overflow	A, S		Capacity reduced by sediment or debris	Remove sediment or debris/dispose
Underdrain pipe	Clean pipe as needed	Clean orifice at least biannually (may need more frequent cleaning during wet season)	• Plant roots, sediment or debris reducing capacity of underdrain • Prolonged surface ponding (see "Ponded water"	• Jet clean or rotary cut debris/roots from underdrain(s) • If underdrains are equipped with a flow restrictor (e.g., orifice) to attenuate flows, the orifice must be cleaned regularly.
Vegetation				

Maintenance Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Facility bottom area and upland slope vegetation	Fall and Spring		Vegetation survival rate falls below 75% within first two years of establishment (unless project O&M manual or record drawing stipulates more or less than 75% survival rate).	• Determine cause of poor vegetation growth and correct condition • Replant as necessary to obtain 75% survival rate or greater. Refer to original planting plan, or approved jurisdictional species list for appropriate plant replacements (See Appendix 3 - Bioretention Plant List, in the *LID Technical Guidance Manual for Puget Sound*, (Hinman and Wulkan, 2012)). • Confirm that plant selection is appropriate for site growing conditions • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
Vegetation (general)	As needed		Presence of diseased plants and plant material	• Remove any diseased plants or plant parts and dispose of in an approved location (e.g., commercial landfill) to avoid risk of spreading the disease to other plants • Disinfect gardening tools after pruning to prevent the spread of disease • See the *Pacific Northwest Plant Disease Management Handbook* (Pscheidt and Ocamb, 2016) for information on disease recognition and for additional resources • Replant as necessary according to recommendations provided for "facility bottom area and upland slope vegetation".
Trees and shrubs		All pruning seasons (timing varies by species)	Pruning as needed	• Prune trees and shrubs in a manner appropriate for each species. Pruning should be performed by landscape professionals familiar with proper pruning techniques • All pruning of mature trees should be performed by or under the direct guidance of an ISA certified arborist
	A		Large trees and shrubs interfere with operation of the facility or access for maintenance	• Prune trees and shrubs using most current ANSI A300 standards and ISA BMPs. • Remove trees and shrubs, if necessary.

Maintenance Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
	Fall and Spring		Standing dead vegetation is present	• Remove standing dead vegetation • Replace dead vegetation within 30 days of reported dead and dying plants (as practical depending on weather/planting season) • If vegetation replacement is not feasible within 30 days, and absence of vegetation may result in erosion problems, temporary erosion control measures should be put in place immediately. • Determine cause of dead vegetation and address issue, if possible • If specific plants have a high mortality rate, assess the cause and replace with appropriate species. Consultation with a landscape architect is recommended.
	Fall and Spring		Planting beneath mature trees	• When working around and below mature trees, follow the most current ANSI A300 standards and ISA BMPs to the extent practicable (e.g., take care to minimize any damage to tree roots and avoid compaction of soil). • Planting of small shrubs or groundcovers beneath mature trees may be desirable in some cases; such plantings should use mainly plants that come as bulbs, bare root or in 4-inch pots; plants should be in no larger than 1-gallon containers.
	Fall and Spring		Presence of or need for stakes and guys (tree growth, maturation, and support needs)	• Verify location of facility liners and underdrain (if any) prior to stake installation in order to prevent liner puncture or pipe damage • Monitor tree support systems: Repair and adjust as needed to provide support and prevent damage to tree. • Remove tree supports (stakes, guys, etc.) after one growing season or maximum of 1 year. • Backfill stake holes after removal.

Maintenance Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Trees and shrubs adjacent to vehicle travel areas (or areas where visibility needs to be maintained)	A		Vegetation causes some visibility (line of sight) or driver safety issues	• Maintain appropriate height for sight clearance • When continued, regular pruning (more than one time/ growing season) is required to maintain visual sight lines for safety or clearance along a walk or drive, consider relocating the plant to a more appropriate location. • Remove or transplant if continual safety hazard • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
Flowering plants		A	Dead or spent flowers present	Remove spent flowers (deadhead)
Perennials		Fall	Spent plants	Cut back dying or dead and fallen foliage and stems
Emergent vegetation		Spring	Vegetation compromises conveyance	Hand rake sedges and rushes with a small rake or fingers to remove dead foliage before new growth emerges in spring or earlier only if the foliage is blocking water flow (sedges and rushes do not respond well to pruning)
Ornamental grasses (perennial)		Winter and Spring	Dead material from previous year's growing cycle or dead collapsed foliage	• Leave dry foliage for winter interest • Hand rake with a small rake or fingers to remove dead foliage back to within several inches from the soil before new growth emerges in spring or earlier if the foliage collapses and is blocking water flow
Ornamental grasses (evergreen)		Fall and Spring	Dead growth present in spring	• Hand rake with a small rake or fingers to remove dead growth before new growth emerges in spring • Clean, rake, and comb grasses when they become too tall • Cut back to ground or thin every 2-3 years as needed

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Noxious weeds		M (March - October, preceding seed dispersal)	Listed noxious vegetation is present (refer to current county noxious weed list)	• By law, class A & B noxious weeds must be removed, bagged and disposed as garbage immediately • Reasonable attempts must be made to remove and dispose of class C noxious weeds • It is strongly encouraged that herbicides and pesticides not be used in order to protect water quality; use of herbicides and pesticides may be prohibited in some jurisdictions • Apply mulch after weed removal (see "Mulch")
Weeds		M (March - October, preceding seed dispersal)	Weeds are present	• Remove weeds with their roots manually with pincer-type weeding tools, flame weeders, or hot water weeders as appropriate • Follow IPM protocols for weed management (see "Additional Maintenance Resources" section for more information on IPM protocols)
Excessive vegetation		Once in early to mid- May and once in early- to mid-September	Low-lying vegetation growing beyond facility edge onto sidewalks, paths, or street edge poses pedestrian safety hazard or may clog adjacent permeable pavement surfaces due to associated leaf litter, mulch, and soil	• Edge or trim groundcovers and shrubs at facility edge • Avoid mechanical blade-type edger and do not use edger or trimmer within 2 feet of tree trunks • While some clippings can be left in the facility to replenish organic material in the soil, excessive leaf litter can cause surface soil clogging

Maintenance Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
	As needed		Excessive vegetation density inhibits stormwater flow beyond design ponding or becomes a hazard for pedestrian and vehicular circulation and safety	• Determine whether pruning or other routine maintenance is adequate to maintain proper plant density and aesthetics • Determine if planting type should be replaced to avoid ongoing maintenance issues (an aggressive grower under perfect growing conditions should be transplanted to a location where it will not impact flow) • Remove plants that are weak, broken or not true to form; replace in-kind • Thin grass or plants impacting facility function without leaving visual holes or bare soil areas • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
	As needed		Vegetation blocking curb cuts, causing excessive sediment buildup and flow bypass	Remove vegetation and sediment buildup
Mulch				
Mulch		Following weeding	Bare spots (without mulch cover) are present or mulch depth less than 2 inches	• Supplement mulch with hand tools to a depth of 2 to 3 inches • Replenish mulch per O&M manual. Often coarse compost is used in the bottom of the facility and arborist wood chips are used on side slopes and rim (above typical water levels) • Keep all mulch away from woody stems
Watering				
Irrigation system (if any)		Based on manufacturer's instructions	Irrigation system present	Follow manufacturer's instructions for O&M
	A		Sprinklers or drip irrigation not directed/located to properly water plants	Redirect sprinklers or move drip irrigation to desired areas

Maintenance Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		

Summer watering (first year)		Once every 1-2 weeks or as needed during prolonged dry periods	Trees, shrubs and groundcovers in first year of establishment period	• 10 to 15 gallons per tree
				• 3 to 5 gallons per shrub
				• 2 gallons water per square foot for groundcover areas
				• Water deeply, but infrequently, so that the top 6 to 12 inches of the root zone is moist
				• Use soaker hoses or spot water with a shower type wand when irrigation system is not present
				  ○ Pulse water to enhance soil absorption, when feasible
				  ○ Pre-moisten soil to break surface tension of dry or hydrophobic soils/mulch, followed by several more passes. With this method , each pass increases soil absorption and allows more water to infiltrate prior to runoff
				• Add a tree bag or slow-release watering device (e.g., bucket with a perforated bottom) for watering newly installed trees when irrigation system is not present

Summer watering (second and third years)		Once every 2-4 weeks or as needed during prolonged dry periods	Trees, shrubs and groundcovers in second or third year of establishment period	• 10 to 15 gallons per tree
				• 3 to 5 gallons per shrub
				• 2 gallons water per square foot for groundcover areas
				• Water deeply, but infrequently, so that the top 6 to 12 inches of the root zone is moist
				• Use soaker hoses or spot water with a shower type wand when irrigation system is not present
				  ○ Pulse water to enhance soil absorption, when feasible
				  ○ Pre-moisten soil to break surface tension of dry or hydrophobic soils/mulch, followed by several more passes. With this method , each pass increases soil absorption and allows more water to infiltrate prior to runoff

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Summer watering (after establishment)		As needed	Established vegetation (after 3 years)	• Plants are typically selected to be drought tolerant and not require regular watering after establishment; however, trees may take up to 5 years of watering to become fully established • Identify trigger mechanisms for drought-stress (e.g., leaf wilt, leaf senescence, etc.) of different species and water immediately after initial signs of stress appear • Water during drought conditions or more often if necessary to maintain plant cover
Pest Control				
Mosquitoes	B, S		Standing water remains for more than 3 days after the end of a storm	• Identify the cause of the standing water and take appropriate actions to address the problem (see "Ponded water") • To facilitate maintenance, manually remove standing water and direct to the storm drainage system (if runoff is from non pollution-generating surfaces) or sanitary sewer system (if runoff is from pollution-generating surfaces) after getting approval from sanitary sewer authority. • Use of pesticides or *Bacillus thuringiensis israelensis* (Bti) may be considered only as a temporary measure while addressing the standing water cause. If overflow to a surface water will occur within 2 weeks after pesticide use, apply for coverage under the Aquatic Mosquito Control NPDES General Permit.

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Nuisance animals	As needed		Nuisance animals causing erosion, damaging plants, or depositing large volumes of feces	• Reduce site conditions that attract nuisance species where possible (e.g., plant shrubs and tall grasses to reduce open areas for geese, etc.) • Place predator decoys • Follow IPM protocols for specific nuisance animal issues (see "Additional Maintenance Resources" section for more information on IPM protocols) • Remove pet waste regularly • For public and right-of-way sites consider adding garbage cans with dog bags for picking up pet waste.
Insect pests	Every site visit associated with vegetation management		Signs of pests, such as wilting leaves, chewed leaves and bark, spotting or other indicators	• Reduce hiding places for pests by removing diseased and dead plants • For infestations, follow IPM protocols (see "Additional Maintenance Resources"□ section for more information on IPM protocols)

Note that the inspection and routine maintenance frequencies listed above are recommended by Ecology. They do not supersede or replace the municipal stormwater permit requirements for inspection frequency required of municipal stormwater permittees for "stormwater treatment and flow control BMPs/facilities".

[a] Frequency: A = Annually; B = Biannually (twice per year); M = Monthly; W = At least one visit should occur during the wet season (for debris/clog related maintenance, this inspection/maintenance visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

IPM - Integrated Pest Management

ISA - International Society of Arboriculture

Table V-A.22: Maintenance Standards - Permeable Pavement

Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Surface/Wearing Course				

Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Permeable Pavements, all	A, S		Runoff from adjacent pervious areas deposits soil, mulch or sediment on paving	• Clean deposited soil or other materials from permeable pavement or other adjacent surfacing • Check if surface elevation of planted area is too high, or slopes towards pavement, and can be regraded (prior to regrading, protect permeable pavement by covering with temporary plastic and secure covering in place) • Mulch and/or plant all exposed soils that may erode to pavement surface

Porous asphalt or pervious concrete		A or B	None (routine maintenance)	Clean surface debris from pavement surface using one or a combination of the following methods:
				• Remove sediment, debris, trash, vegetation, and other debris deposited onto pavement (rakes and leaf blowers can be used for removing leaves)
				• Vacuum/sweep permeable paving installation using:
				  ○ Walk-behind vacuum (sidewalks)
				  ○ High efficiency regenerative air or vacuum sweeper (roadways, parking lots)
				  ○ ShopVac or brush brooms (small areas)
				• Hand held pressure washer or power washer with rotating brushes Follow equipment manufacturer guidelines for when equipment is most effective for cleaning permeable pavement. Dry weather is more effective for some equipment.

Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		

	A_b		Surface is clogged: Ponding on surface or water flows off the permeable pavement surface during a rain event (does not infiltrate)	• Review the overall performance of the facility (note that small clogged areas may not reduce overall performance of facility)
				• Test the surface infiltration rate using ASTM C1701 as a corrective maintenance indicator. Perform one test per installation, up to 2,500 square feet. Perform an additional test for each additional 2,500 square feet up to 15,000 square feet total. Above 15,000 square feet, add one test for every 10,000 square feet.
				• If the results indicate an infiltration rate of 10 inches per hour or less, then perform corrective maintenance to restore permeability. To clean clogged pavement surfaces, use one or combination of the following methods:
				  ○ Combined pressure wash and vacuum system calibrated to not dislodge wearing course aggregate.
				  ○ Hand held pressure washer or power washer with rotating brushes
				  ○ Pure vacuum sweepers
				Note: If the annual/biannual routine maintenance standard to clean the pavement surface is conducted using equipment from the list above, corrective maintenance may not be needed.

	A		Sediment present at the surface of the pavement	• Assess the overall performance of the pavement system during a rain event. If water runs off the pavement and/or there is ponding then see above. • Determine source of sediment loading and evaluate whether or not the source can be reduced/eliminated. If the source cannot be addressed, consider increasing frequency of routine cleaning (e.g., twice per year instead of once per year).

Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
	Summer		Moss growth inhibits infiltration or poses slip safety hazard	• Sidewalks: Use a stiff broom to remove moss in the summer when it is dry • Parking lots and roadways: Pressure wash, vacuum sweep, or use a combination of the two for cleaning moss from pavement surface. May require stiff broom or power brush in areas of heavy moss.
	A		Major cracks or trip hazards and concrete spalling and raveling	• Fill potholes or small cracks with patching mixes • Large cracks and settlement may require cutting and replacing the pavement section. Replace in-kind where feasible. Replacing porous asphalt with conventional asphalt is acceptable if it is a small percentage of the total facility area and does not impact the overall facility function. • Take appropriate precautions during pavement repair and replacement efforts to prevent clogging of adjacent porous materials

Interlocking concrete paver blocks and aggregate pavers		A or B	None (routine maintenance)	Clean pavement surface using one or a combination of the following methods:
				• Remove sediment, debris, trash, vegetation, and other debris deposited onto pavement (rakes and leaf blowers can be used for removing leaves)
				• Vacuum/sweep permeable paving installation using:
				  ○ Walk-behind vacuum (sidewalks)
				  ○ High efficiency regenerative air or vacuum sweeper (roadways, parking lots)
				  ○ ShopVac or brush brooms (small areas)
				Note: Vacuum settings may have to be adjusted to prevent excess uptake of aggregate from paver openings or joints. Vacuum surface openings in dry weather to remove dry, encrusted sediment.

Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
	A_b		Surface is clogged: Ponding on surface or water flows off the permeable pavement surface during a rain event (does not infiltrate)	• Review the overall performance of the facility (note that small clogged areas may not reduce overall performance of facility) • Test the surface infiltration rate using ASTM C1701 as a corrective maintenance indicator. Perform one test per installation, up to 2,500 square feet. Perform an additional test for each additional 2,500 square feet up to 15,000 square feet total. Above 15,000 square feet, add one test for every 10,000 square feet. • If the results indicate an infiltration rate of 10 inches per hour or less, then perform corrective maintenance to restore permeability. • Clogging is usually an issue in the upper 2 to 3 centimeters of aggregate. Remove the upper layer of encrusted sediment, and fines, and/or vegetation from openings and joints between the pavers by mechanical means and/or suction equipment (e.g., pure vacuum sweeper). • Replace aggregate in paver cells, joints, or openings per manufacturer's recommendations
	A		Sediment present at the surface of the pavement	• Assess the overall performance of the pavement system during a rain event. If water runs off the pavement and/or there is ponding, then see above. • Determine source of sediment loading and evaluate whether or not the source can be reduced/eliminated. If the source cannot be addressed, consider increasing frequency of routine cleaning (e.g., twice per year instead of once per year).
	Summer		Moss growth inhibits infiltration or poses slip safety hazard	• Sidewalks: Use a stiff broom to remove moss in the summer when it is dry • Parking lots and roadways: Vacuum sweep or stiff broom/power brush for cleaning moss from pavement surface
	A		Paver block missing or damaged	Remove individual damaged paver blocks by hand and replace or repair per manufacturer's recommendations

Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
	A		Loss of aggregate material between paver blocks	Refill per manufacturer's recommendations for interlocking paver sections
	A		Settlement of surface	May require resetting
Open-celled paving grid with gravel		A or B	None (routine maintenance)	• Remove sediment, debris, trash, vegetation, and other debris deposited onto pavement (rakes and leaf blowers can be used for removing leaves) • Follow equipment manufacturer guidelines for cleaning surface.
	A[b]		Aggregate is clogged: Ponding on surface or water flows off the permeable pavement surface during a rain event (does not infiltrate)	• Use vacuum truck to remove and replace top course aggregate • Replace aggregate in paving grid per manufacturer's recommendations
	A		Paving grid missing or damaged	• Remove pins, pry up grid segments, and replace gravel • Replace grid segments where three or more adjacent rings are broken or damaged • Follow manufacturer guidelines for repairing surface.
	A		Settlement of surface	May require resetting
	A		Loss of aggregate material in paving grid	Replenish aggregate material by spreading gravel with a rake (gravel level should be maintained at the same level as the plastic rings or no more than 1/4 inch above the top of rings). See manufacturer's recommendations.
		A	Weeds present	• Manually remove weeds • Presence of weeds may indicate that too many fines are present (refer to Actions Needed under "Aggregate is clogged"□ to address this issue)

Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Open-celled paving grid with grass		A or B	None (routine maintenance)	• Remove sediment, debris, trash, vegetation, and other debris deposited onto pavement (rakes and leaf blowers can be used for removing leaves) • Follow equipment manufacturer guidelines for cleaning surface.
	A_b		Aggregate is clogged: Ponding on surface or water flows off the permeable pavement surface during a rain event (does not infiltrate)	Rehabilitate per manufacturer's recommendations.
	A		Paving grid missing or damaged	• Remove pins, pry up grid segments, and replace grass • Replace grid segments where three or more adjacent rings are broken or damaged • Follow manufacturer guidelines for repairing surface.
	A		Settlement of surface	May require resetting
	A		Poor grass coverage in paving grid	• Restore growing medium, reseed or plant, aerate, and/or amend vegetated area as needed • Traffic loading may be inhibiting grass growth; reconsider traffic loading if feasible
		As needed	None (routine maintenance)	Use a mulch mower to mow grass
		A	None (routine maintenance)	• Sprinkle a thin layer of compost on top of grass surface (1/2"□ top dressing) and sweep it in • Do not use fertilizer
		A	Weeds present	• Manually remove weeds • Mow, torch, or inoculate and replace with preferred vegetation
Inlets/Outlets/Pipes				

Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Inlet/outlet pipe	A		Pipe is damaged	Repair/replace
	A		Pipe is clogged	Remove roots or debris
Underdrain pipe	Clean pipe as needed	Clean orifice at least biannually (may need more frequent cleaning during wet season)	Plant roots, sediment or debris reducing capacity of underdrain (may cause prolonged drawdown period)	• Jet clean or rotary cut debris/roots from underdrain(s) • If underdrains are equipped with a flow restrictor (e.g., orifice) to attenuate flows, the orifice must be cleaned regularly
Raised subsurface overflow pipe	Clean pipe as needed	Clean orifice at least biannually (may need more frequent cleaning during wet season)	Plant roots, sediment or debris reducing capacity of underdrain	• Jet clean or rotary cut debris/roots from under-drain(s) • If underdrains are equipped with a flow restrictor (e.g., orifice) to attenuate flows, the orifice must be cleaned regularly
Outlet structure	A, S		Sediment, vegetation, or debris reducing capacity of outlet structure	• Clear the blockage • Identify the source of the blockage and take actions to prevent future blockages
Overflow	B		Native soil is exposed or other signs of erosion damage are present at discharge point	Repair erosion and stabilize surface
Aggregate Storage Reservoir				
Observation port	A, S		Water remains in the storage aggregate longer than anticipated by design after the end of a storm	If immediate cause of extended ponding is not identified, schedule investigation of subsurface materials or other potential causes of system failure.
Vegetation				

Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Adjacent large shrubs or trees		As needed	Vegetation related fallout clogs or will potentially clog voids	• Sweep leaf litter and sediment to prevent surface clogging and ponding • Prevent large root systems from damaging subsurface structural components
		Once in May and Once in September	Vegetation growing beyond facility edge onto sidewalks, paths, and street edge	Edging and trimming of planted areas to control groundcovers and shrubs from overreaching the sidewalks, paths and street edge improves appearance and reduces clogging of permeable pavements by leaf litter, mulch and soil.
Leaves, needles, and organic debris		In fall (October to December) after leaf drop (1-3 times, depending on canopy cover)	Accumulation of organic debris and leaf litter	Use leaf blower or vacuum to blow or remove leaves, evergreen needles, and debris (i.e., flowers, blossoms) off of and away from permeable pavement

Note that the inspection and routine maintenance frequencies listed above are recommended by Ecology. They do not supersede or replace the municipal stormwater permit requirements for inspection frequency required of municipal stormwater permittees for "stormwater treatment and flow control BMPs/facilities".

a Frequency: A= Annually; B= Biannually (twice per year); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

b Inspection should occur during storm event.

Table V-A.23: Maintenance Standards - Vegetated Roofs

Activity	Objective	Schedule	Notes
Structural and Drainage Components			
Clear inlet pipes: Remove soil substrate, vegetation or other debris.	Maintain free drainage of inlet pipes.	Twice annually.	
Inspect drain pipe: Check for cracks settling and proper alignment, and correct and re-compact soils or fill material surrounding pipe, if necessary.	Maintain free drainage of inlet pipes.	Twice annually.	

Activity	Objective	Schedule	Notes
Inspect fire ventilation points for proper operation	Fire and safety.	Twice annually.	
Maintain egress and ingress: Clear routes of obstructions and maintained to design standards.	Fire and safety.	Twice annually.	
Insects: (see note)			Roof garden design should provide drainage rates that do not allow pooling of water for periods that promote insect larvae development. If standing water is present for extended periods correct drainage problem. Chemical sprays should not be used.
Prevent release of contaminants: Identify activities (mechanical systems maintenance, pet access, etc.) that can potentially release pollutants to the roof garden and establish agreements to prevent release.	Water quality protection.	During construction of roof and then as determined by inspection.	Any cause of pollutant release should be corrected as soon as identified and the pollutant removed.
Vegetation and Growth Medium			
Invasive or nuisance plants: Remove manually and without herbicide applications.	Promote selected plant growth and survival, maintain aesthetics.	Twice annually.	At a minimum, schedule weeding with inspections to coincide with important horticultural cycles (e.g., prior to major weed varieties dispersing seeds).
Removing and replacing dead material: (see note)	See note.	Once annually.	Normally, dead plant material will be recycled on the roof; however specific plants or aesthetic considerations may warrant removing and replacing dead material (see manufacturer's recommendations).
Fertilization: If necessary apply by hand (see note)	Plant growth and survival.	Determined by inspection.	Extensive roof gardens should be designed to not require fertilization after plant establishment. If fertilization is necessary during plant establishment or for plant health and survivability after establishment, use an encapsulated, slow release fertilizer (excessive fertilization can contribute to increased nutrient loads in the stormwater system and receiving waters).
Mulching: (see note)			Avoid application of mulch on extensive roof gardens. Mulch should be used only in unusual situations and according to the roof garden provider guidelines. In conventional landscaping mulch enhances moisture retention; however, moisture control on a vegetated roof should be through proper soil/growth media design. Mulch will also increase establishment of weeds.

Activity	Objective	Schedule	Notes
Irrigate: Use subsurface or drip irrigation.		Determined by inspection and only when absolutely necessary for plant survival.	Surface irrigation systems on extensive roof gardens can promote weed establishment, root development near the drier surface layer of the soil substrate, and increase plant dependence on irrigation. Accordingly, subsurface irrigation methods are preferred. If surface irrigation is the only method available, use drip irrigation to deliver water to the base of the plant.
Source: Eastern Washington LID Guidance Manual (June 2013)			

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